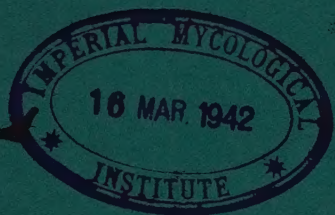


THE EAST AFRICAN

AGRICULTURAL JOURNAL



of
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TANGANYIKA
UGANDA AND
ZANZIBAR**

•
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**THE DURABILITY OF SOME UGANDA
TIMBERS AND POLES IN THE GROUND—I**

**THE SUITABILITY OF THE WHITE HIGH-
LANDS OF KENYA FOR GRADE CATTLE
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**SOME NOTES ON THE MANAGEMENT OF
THE MULTIPLE-STEM SYSTEM OF GROW-
ING COFFEE AT THE LOWER ALTITUDES
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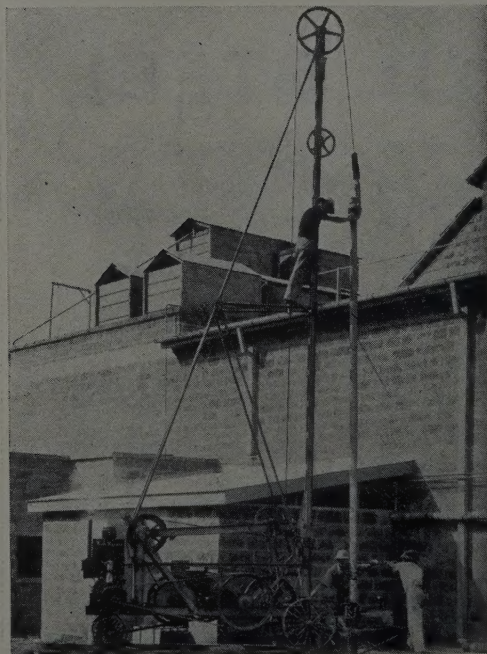
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Matter submitted for publication should preferably be sent through the local member of the Editorial Board. Manuscripts should conform with the recommendations contained in *Notes for Authors*, which may be obtained from the Government Printer, Nairobi, or from a member of the Editorial Board.

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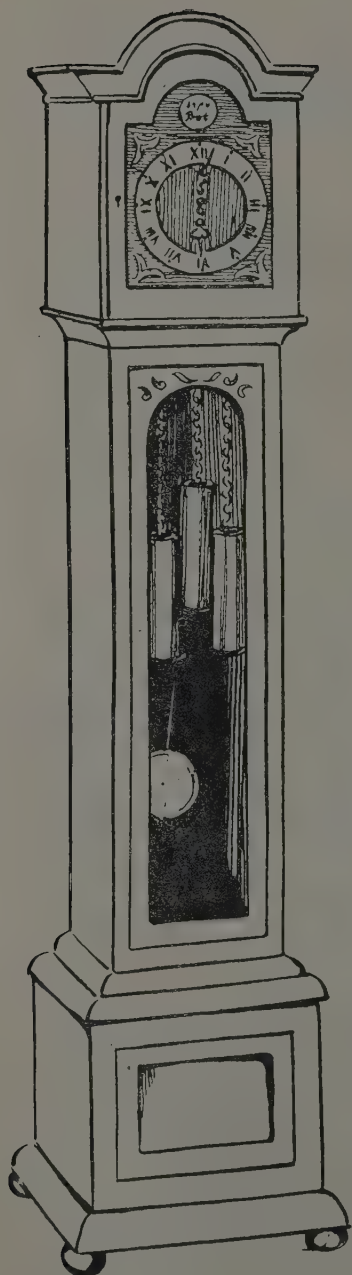
Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Director of Agriculture, and not to Amani.

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FOREWORD

To dwellers in the tropics the short life of cut timber is a perennial curse. In this number of the Journal Mr. R. G. Sangster, of the Uganda Forest Department, describes the results of "graveyard" tests on poles and timbers derived from a large number of East African trees. Since many of these grow in Kenya, Tanganyika and Uganda the results are of general interest. Mr. Sangster stresses that his conclusions are only preliminary, but he is nevertheless able to recommend a number of species as being consistently good. It is somewhat surprising that those species which failed mostly did so from rot, termite attack frequently being secondary. Preliminary tests with preservatives on some of the weaker timbers showed that pure creosote was less effective than a mixture of paraffin and creosote.

A plea for the development of animal husbandry as a better means of controlling soil erosion is made by Mr. R. R. Staples in his article on "Combating Soil Erosion in the Central Province of Tanganyika Territory," the first part of which we publish in this number. His subject is of special importance as it deals with an area that has suffered from extreme deterioration. The usual causes, local overstocking and reckless methods of agriculture, are to blame, aided by accelerated erosion due to the vagaries of climate. For instance, three inches out of an annual rainfall of twenty to thirty inches may fall in a single hour, while in places the run-off may amount to as much as 75 per cent of the fall. A fact favouring attempts to counter the land deterioration is the fertility of the soil. Even after severe erosion, poor as the rainfall is, vegetation makes wonderful progress in protected areas. In general, Mr. Staples regards a deferred grazing system as the most efficient method of

saving the land; and he recognizes that in schemes for the development of the Central Province emphasis should be laid on animal husbandry rather than on arable farming.

Mr. Masefield in his article deals, by contrast, with the better-watered country of Uganda and certain anti-erosion measures recommended for those conditions.

Many readers of the Journal will remember a recent contribution by Dr. M. H. French under the provocative title "The Failure of Pure and High-grade European Cattle in Hot Climates." In the present number Mr. R. Daubney returns to the subject. He makes an exhaustive analysis of the results, both experimental and practical, of work on cattle of European stock in a number of widespread areas possessing a climate hotter than that in which the cattle were developed. The several factors alleged to be associated with the admitted degeneration in many hot climates are discussed separately. His conclusion is that, with good management, the use of European stock fails to be advantageous only where the mean annual temperature exceeds 65° F. Mr. Daubney observes that in Kenya most areas where the cattle industry is established under European management comply with this climate requirement. For marginal areas where attempts are being made to extend the industry he gives most valuable, practical advice.

ADDENDUM

In the notice of Vaughan's "The Grasses of Mauritius and Rodriguez" (p. 101 of the October number), mention should have been made of Hubbard's *East African Pasture Plants* (two vols., 1926-27, published by the Crown Agents for the Colonies, price 5/6). This consists of descriptions and figures of fifty species of East African grasses—a very small proportion, however, of the whole grass flora,

THE DURABILITY OF SOME UGANDA TIMBERS AND POLES IN THE GROUND

PART I

By R. G. Sangster, B.Sc., Assistant Conservator of Forests, Uganda

The relative durability of different timbers in the ground is frequently under discussion, and timber merchants and forest officers are constantly receiving questions on the subject. These notes are not a final answer to such questions, but indicate from the results of a controlled test what species might be worth trying. Even species found to be readily perishable in the soil cannot be rejected out of hand as unworthy of trial until consideration has been given to the possibility of increasing their resistance to termites and rot by the use of preservatives.

In the past there have been many hasty trials of wood in contact with the soil, and in some cases failures have given a bad name to certain species. It must be pointed out that the sapwood of almost all timbers is perishable, and that too frequently a species has been condemned or criticized before the critic has ascertained whether sapwood was included in the specimens observed. In discussing squared timber as distinct from poles, these notes deal with heartwood only, and users are recommended, when selecting timber to be placed in the ground, to specify heartwood if they wish to obtain the best results.

These notes do not deal with the abilities of timbers to bear stresses and strains, but with their resistance to termites and rot under conditions in which these enemies have had the greatest play. While the durability test has been made under conditions of climate, elevation, soil and vegetation which obtain over a large part of Uganda, it is not claimed that the results are applicable to the whole Protectorate. At high elevations or in very dry areas findings might be totally different. Nor can they be literally applied to every use of wood in contact with the soil. In buildings, for example, a reasonable amount of protection is afforded from extremes of damp and heat, and even from termites, and one would expect in such circumstances that timber and poles would last longer than they have done in the "graveyard" where no protection has been given. The preliminary results of the test, therefore, are merely suggestive.

This paper is divided into three sections. The first deals with the durability of squared timber of certain species; the second with small round poles suitable for huts and temporary buildings, and the third with two species, yielding large

poles of a size suitable for telegraph poles, on which preservatives were tried. Tables are given in each section showing the rate of failure of the species tested. Remarks are made in the tables on the causes of failure and the state of pieces remaining at the end of the test. The data in the tables are then discussed and recommendations are made. A short note is given on each species, including its trade and vernacular names and its distribution in Uganda.

CONDITIONS AND METHOD OF TESTING

The "graveyard" in which the durability test was made is an acre of ground cleared from elephant grass, near Budongo Forest Station, on the Masindi-Butiaba road. The elevation is 3,600 feet. It is well sheltered from winds but fully exposed to sun. A gentle slope towards the east provides free drainage and the soil is a deep red clay with a black, humus surface layer. Rainfall in the area averages 60.52 inches (four years), falling in two seasons, and temperatures range from 11° C. to 30° C. There are several termite nests in the vicinity but none actually within the "graveyard".

Specimens for testing were planted in rows three feet apart at intervals of three feet within the rows, and the final appearance of the area accounts for its lugubrious name. The sequence of the lay-out was based on the principle of the simple chessboard—ABCDE, ABCDE, etc.—but was complicated by the facts that a perfect square was not obtainable and that the number of specimens for each treatment varied. Considerable randomization was thus obtained.

Assessments were made by lifting the specimens at irregular intervals not exceeding six months, and any specimen having more than half the heartwood of the underground portion eaten or rotted away was rejected as a failure. Notes were made on the extent or absence of damage found on unrejected specimens and these were returned to the ground.

Section I—Timber

Species of trees obtainable in large sizes and normally sawn for use in more or less permanent work. Specimens were three feet long, squared to three inches by three inches, free, as far as could be judged, from sapwood and defects, and buried half their length in the ground. The tests lasted for four to five and a half years, and the results are summarized in the following table:—

TABLE 1
UNTREATED SAWN TIMBERS

SUMMARY OF ASSESSMENTS IN PERCENTAGE FAILURES

SPECIES	No. of pieces	PERCENTAGE FAILURES AFTER—MONTHS																REMARKS
		5	9	13	15	18	21	27	30	33	36	42	48	54	60	MM		
<i>Albizzia coriaria</i> Welw.	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Four show traces of rot at ground level; rest sound.	
<i>Aningeria altissima</i> (A. Chev.) Aubr. & Pellegr.	20	20	50	50	90	×	×	×	×	×	×	×	×	×	×	×	Termites and rot combined.	
<i>Chlorophora excelsa</i> Benth. & Hook. f.	20	—	—	—	—	—	—	—	—	—	—	—	—	5	15	20	Failures from rot and termites, probably combined. Nine attacked and abandoned by termites, damage negligible. Two weakened by termites and rot, Three by rot only, one slightly; two badly.	
<i>Chrysophyllum albidum</i> G. Don	20	30	35	40	60	95	100	×	×	×	×	×	×	×	×	×	Primary attack by termites but rot (prominent after a year) combining in destruction.	
<i>Chrysophyllum perpulchrum</i> Mildbr. ex Hutch. & Dalz.	20	20	35	45	70	100	×	×	×	×	×	×	×	×	×	×	Termites and rot combined throughout the test.	
<i>Chrysophyllum</i> sp. nov.	20	—	45	65	85	100	×	×	×	×	×	×	×	×	×	×	As above.	
<i>Cynometra alexandri</i> C. H. Wright	20	—	—	—	—	—	—	—	—	—	—	—	5	10	20	20	First failure due to rot, rest to rot followed by termites. Seven show slight, abortive termite damage at ground level, probably following decay; four have slight rot at ground level.	
<i>Daniellia oliveri</i> (Rolfe) Hutch. & Dalz.	10	—	40	40	50	50	70	100	×	×	×	×	×	×	×	×	Termites and rot combined.	
<i>Entandrophragma angolense</i> C. DC.	20	—	—	—	5	45	65	65	70	70	70	70	×	×	×	×	Rot primary; in some cases followed by termites.	
<i>Entandrophragma cylindricum</i> Sprague	20	—	—	—	5	5	30	30	40	40	40	40	45	60	×	×	Rot primary, termites secondary: both active. Only two pieces left completely sound.	
<i>Entandrophragma exceleum</i> Sprague	20	45	50	55	×	×	×	×	×	×	×	×	×	×	×	×	Termites sole cause of failure.	
<i>Entandrophragma utile</i> Sprague	20	—	—	—	—	5	5	10	25	25	45	55	65	70	×	×	Termites primary, rot secondary. None left free from attack.	
<i>Erythrophloeum guineense</i> G. Don	20	—	—	—	—	—	—	—	5	5	5	5	5	5	5	5	Failure due to rot, followed by termites. Termites tended to abandon pieces after initial attack but one piece re-attacked after 3 years. One piece badly rotted and attacked by borer above ground.	
<i>Juniperus procera</i> Hochst. (From Kenya)	10	—	—	—	—	—	—	—	—	—	—	20	20	40	40	×	Termites attacked and abandoned most pieces: then re-attacked and destroyed four.	
<i>Khaya anthotheca</i> C. DC.	20	20	35	45	50	90	95	95	95	95	95	×	×	×	×	×	Termites almost sole destroyers.	

TABLE 1—(Cont.)
 UNTREATED SAWN TIMBERS
 SUMMARY OF ASSESSMENTS IN PERCENTAGE FAILURES

SPECIES	No of pieces	PERCENTAGE FAILURES AFTER—MONTHS																REMARKS
		5	9	13	15	18	21	27	30	33	36	42	48	54	60	66		
<i>Khaya grandifoliola</i> C. DC.	20	15	40	40	45	45	50	55	×	×	×	×	×	×	×	×	Termites primary cause of failure.	
<i>Loqua brownii</i> Sprague	20	—	—	—	—	—	—	—	10	10	10	10	35	55	×	×	Rot primary, termites completed damage in most cases.	
<i>Maesopsis eminii</i> Engl.	20	5	40	45	65	90	95	95	95	95	95	×	×	×	×	×	Rot primary; termites secondary.	
<i>Mildbraediodendron excelsum</i> Harms	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Very slight rot at ground level on four pieces only.	
<i>Parinari excelsa</i> Sabine	20	—	10	10	55	×	×	×	×	×	×	×	×	×	×	×	Termites and rot combined.	
<i>Piptadenia africana</i> Hook. f.	20	5	5	5	20	25	35	40	45	45	45	45	70	×	×	×	Rot and termites combined.	
<i>Podocarpus gracilior</i> Pilger (From Kenya)	16	—	20	60	100	×	×	×	×	×	×	×	×	×	×	×	Termites and wet rot combined.	
<i>Podocarpus milanjianus</i> Rendle	10	—	10	20	90	100	×	×	×	×	×	×	×	×	×	×	Rot possibly primary. Termites later combined with it.	

Bearing in mind that the "graveyard" test shows failure or durability under the most rigorous conditions, but does not tell the maximum life of timber when properly cared for, we must treat the results as being indicative only, and capable of literal application only to conditions exactly resembling those of the test. It is impossible to classify the foregoing timbers into durable and non-durable after the brief space of four years, since the most resistant timbers are still being tested. A looser grouping is therefore used whereby timbers are graded as "Recommended," "Doubtful," and "Not Recommended." Only the best timbers come into the "Recommended" group.

A—Recommended

Timbers showing not more than 10 per cent failures in four years; 10 per cent is taken as the maximum possible number of failure due to the faulty selection of timber which had unseen defects. The state of the remainder indicates whether this is so.

Albizzia coriaria Welw.; *Musita* (Lusoga); *Mugavu* (Luganda); *Musisa* (Lunyoro, Lutoro); *Etekwa* (Luteso).

Savanna tree, occasionally found in forest where it attains a considerable size. In savanna it branches low and seldom has a clean bole for more than 15 feet. Girth is usually 12 feet at breast height.

Found in all districts.

Chlorophora excelsa Benth. & Hook. f.; *Iroko* (trade name); *Muvule* (local trade name); *Muvule* (Luganda); *Mvule* (Ki-

swahili); *Mutumba* (Lunyoro); *Olwaa* (Acholi); *Mbala* (Kwamba); *Vundi* (Madi).

The timber derived from savanna-grown trees frequently contains "stone", a calcareous deposit in the vicinity of old wounds, which is liable to break saws. Weight 45-48 lb. per cubic foot air-dried.

Found in Mengo, Entebbe, Sesse, Masaka, Mubende, Toro (Bwamba), Bunyoro, West Nile (rare), Madi, Acholi (rare), Lango (rare), Teso, Bugwere, Bugishu, Budama, Busoga.

Cynometra alexandri C. H. Wright; *Muhimbi* (trade name); *Muhimbi*, *Muhindi* (Lunyoro).

A forest tree, growing in great abundance where it is found, but seldom very large owing to fluting of the stem. The wood is red, very hard and heavy.

Found in Bunyoro, Toro, Ankole (Lake Lutoto), Kigezi (Marabigambo Forest).

Erythrophloeum guineense G. Don; *Mumara* (local trade name); *Mumara* (Lunyoro).

Wood very heavy, very hard, easily split by nails. Weight 60 lb. per cubic foot air-dried. The tree is large but the bole not usually very tall.

Found in Sesse, Bunyoro, Madi, Acholi.

Mildbraediodendron excelsum Harms; *Muyati* (local trade name used in Bunyoro); *Nkoba* (Lunyoro).

A common tree in the Budongo Forest, clean-boled and straight. Wood resembles Muvule in appearance. Weight 58 lb. per cubic foot air-dried.

Found in Kigezi (Marabigambo Forest), Bunyoro, Madi (Zoka Forest).

B—Doubtful

Timbers showing 10 per cent to 50 per cent failures in four years.

Entandrophragma utile Sprague; *Mufumbi* (local trade name); *Mufumbi* (Lunyoro); *Muyovu* (Luganda, Lunyoro).

Found in Mengo, Entebbe, Toro, Bunyoro, Madi (Zoka Forest).

Juniperus procera Hochst.; African Pencil Cedar (trade name); Cedar (local trade name); *Tolokyo* (Sabei).

Wood light, straight-grained, easily split, easy to work and finish. Weight 32 to 38 lb. per cubic foot air-dried.

Found in Karamoja (Timu Forest and Mt. Moroto), Bugishu (Mt. Elgon).

Lova brownii Sprague; *Nkoba* (local trade name); *Nkoba* (Luganda, Lunyoro); *Mukusu* (Lutoro).

Weight 36½ lb. per cubic foot air-dried.

Found in Mengo, Entebbe, Sesse, Toro, Bunyoro.

C—Not Recommended

Timbers with over 50 per cent failures in four years and therefore unlikely to last very long unless treated with preservatives.

Aningeria altissima (A. Chev.) Aubr. and Pellegr.

The timber is of good quality, easy to saw, and suitable for constructional work.

Found in Mengo, Ankole, Toro (Bwamba), Bunyoro, West Nile, Acholi, Bugishu.

Chrysophyllum albidum G. Don; *Mululu* (Luganda, Lunyoro); *Nkalate* (Luganda of Buddu).

Timber takes nails well and saws and planes easily. Weight 44 lb. per cubic foot air-dried.

Found in Masaka, Ankole, Toro, Bunyoro, Budama, Busoga.

Chrysophyllum perpulchrum Milbr. ex Hutch. & Dalz.; *Mubukampungu* (Lunyoro).

Being fissile, it does not take nails well, and it is hard to saw. Weight 64 lb. per cubic foot air-dried.

Found in Bunyoro.

Chrysophyllum sp. nov.?; *Munyamata* (Lunyoro).

Easy to saw and plane, finishing and polishing well. It will not take nails, being fissile.

Found in Bunyoro, Toro.

Daniellia oliveri (Rolfe) Hutch. & Dalz.; *Bito*, *Bitoke* (Lugbara); *Masa* (Madi).

Wood easily worked. Weight 44 lb. per cubic foot air-dried.

Found in West Nile, West Madi.

Entandrophragma angolense (Welw.) C. DC.; *Mukusu* (local trade name); *Mukusu* (Luganda); *Muyovu* (Lunyoro, Luganda).

Easy to work with all tools. Weight 39-40 lb. per cubic foot air-dried.

Found in Entebbe, Mengo, Toro, Bunyoro, Madi (Zoka Forest).

Entandrophragma cylindricum Sprague; *Sapele* (trade name); *Muyovu* (local trade name); *Muyovu* (Luganda, Lunyoro).

Found in Mengo, Bunyoro.

Entandrophragma excelsum Sprague; *Muyovu* (Lunyankole); *Omuyove* (Lukiga).

Weight about 35 lb. per cubic foot air-dried.

Found in Kigezi, Ankole, Toro.

Khaya anthotheca C. DC.; African Mahogany (trade name); *Munyama*, Uganda Mahogany (local trade names); *Kirumbo* (Kwamba); *Munyama* (Lunyoro).

Found in Toro, Bunyoro.

Khaya grandifoliola C. DC.; African Mahogany (trade name); *Eri* (Madi); *Mario* (Lugbara); *Munyama* (Lunyoro); *Tido* (Acholi).

Found in Bunyoro, West Nile, Madi, Acholi. *Maesopsis eminii* Engl.; *Musizi* (local trade name); *Musizi* (Luganda); *Muhongera* (Lunyoro).

A well-grown tree, usually common where it is found. Impregnates readily. Being short-fibred, it breaks under strain and cannot be used to carry heavy loads.

Found in Mengo, Entebbe, Masaka, Ankole, Mubende, Busoga.

Parinari excelsa Sabine; *Ebura* (Lutoro); *Mubura* (Lunyankole); *Munazi* (Luganda of Buddu); *Mushimba* (Luchiga).

The wood is tough, difficult to saw, tending to pick up under the plane, resistant to nails, and turns badly. Weight 51-56 lb. per cubic foot air-dried.

Found in Masaka, Ankole, Kigezi, Toro, Bunyoro, West Nile.

Piptadenia africana Hook. f.; *Mpewere* (Luganda); *Muchenche* (Lutoro); *Mugeye* (Lunyoro); *Mukunga* (Luchiga).

Found in Mengo, Entebbe, Kigezi, Toro, Bunyoro.

Podocarpus gracilior Pilger; Podo (trade name); *Musenene* (Luganda); *Obwipe* (Lukonjo).

Wood easily impregnated. Weight about 31 lb. per cubic foot air-dried.

Found in Masaka (South Buddu Forests), Kigezi (impenetrable forest), Acholi (Imatong Mountains), Karamoja (Mt. Debasien), Bugishu (Mt. Elgon).

Podocarpus milanjanus Rendle; Podo (trade name); *Musenene* (Luganda); *Omuhulizi* (Lukiga); *Obwipe* (Lukonjo).

Wood like *P. gracilior*.

Found in Masaka (South Buddu Forests), Kigezi (impenetrable forest), Toro (Mt. Ruwenzori), Bugishu (Mt. Elgon).

Preservatives

A trial with preservatives was made during the five-year period of the "graveyard" test.

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Maesopsis eminii (Musizi) and the two Podos were selected for treatment, all belonging to Group C. Conclusive results cannot be given in view of the poor facilities for proper application of the preservatives, the short duration of the test, and the small number of pieces treated.

It appears, however, that a half-and-half mixture of creosote and paraffin is a considerable improvement on creosote alone, and that application of preservatives hot (preferably by boiling the timber in them) is superior to cold application by brushing, penetration being greater.

With *Maesopsis eminii*, preservatives merely delayed failure slightly, but treated with the hot mixture of creosote and paraffin both Podos have remained sound for four years—a significant change from the early failures of these species when untreated.

(To be continued)

POISON FOR SILVERFISH

Silverfish, the long grayish insects that scamper through stored books, papers and linens, have had their private lives examined and their death warrant written. The likes and dislikes of these elusive pests that destroy valuable papers, books and heirlooms have been discovered by Arnold Mallis, entomologist of the University of California at Los Angeles.

The species used by Mr. Mallis in his studies, called *Ctenolepisma urbani* by entomologists, is unable to survive a spray of pyrethrum. When the silverfish is confined in a pyrethrum dust it shows great signs of irritation, often within thirty seconds. The pyrethrum dust adheres to the hairs on the body and around the mouth parts, as well as upon all appendages. The insect becomes paralysed within from three to ten minutes.

Sodium fluoride and sodium fluosilicate have been used in the past to control silverfish but were only partially effective. If these poisons are combined with pyrethrum, the lethal result to the pests is greatly enhanced. Treated "cards" sold commercially for silverfish control have little effect on the pests.

The diet preference of silverfish was also studied, and it was found that animal fibres, such as silk and wool, are not as popular with the pests as vegetable fibres, linen, rayon, cotton, and lisle. As all paper and fine old linens are made from vegetable fibre sources, this explains their choice of libraries and linen closets for habitation. The insects are very fond of cellophane, kleenex, and onion-skin paper, preferring these materials to newspaper and cardboard.

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THE SUITABILITY OF THE WHITE HIGHLANDS OF KENYA FOR GRADE CATTLE OF EUROPEAN BREEDS

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It has long been appreciated that European cattle in the tropics are subject to grave disabilities, which in the course of a few generations may lead to a decrease in body-size and weight, heaviness of withers and shoulder, legginess, lightness of bone, staggyiness of horns, a steady decline with successive generations in milk production, lowered fertility, an unthrifty condition of the skin, and a general proneness to suffer severely from what are usually regarded as minor diseases and ailments. It is common to refer to these characters as manifestations of "loss of constitution".

This loss of constitution has been remarked in European breeds in the Southern United States, the West Indies, the Philippines, Africa and India, the tropics of Queensland and the Northern Territory of Australia. It has been attributed in turn to nutritional deficiencies, to lack of inherited resistance to the less fatal enzootic diseases of indigenous cattle, and to the effect of climatic conditions on the heat-regulatory mechanism of the animals. In recent years, a few comparative investigations of the heat-regulatory mechanism of cattle have been made, which have attracted considerable attention because of the striking breed or species differences that it has been possible to demonstrate in the physiological behaviour of European and Zebu cattle at relatively high atmospheric temperatures.

Assuming for the moment that each of the three factors contributes in some degree to the degeneration of European or high-grade cattle, it will be evident that in their incidence and comparative importance they will act differently on beef and dairy types. Thus the intensively managed dairy herd is less likely to suffer from gross nutritional deficiency (as distinct from deficiency diseases proper) than the beef herd on open range. So far as disease resistance is concerned, again the intensively managed dairy animal is less likely to be left to take its chance unaided of surviving minor enzootic infections than the ranch animal of lower capital value, which is bred in greater numbers. It will be equally obvious that economy in water utilization is of less importance in the dairy animal than in the ranch beef animal.

It is proposed to refer very briefly to the first two of these factors and, although it would be quite impossible to cover the work on the third factor thoroughly, it will receive rather more detailed consideration since it is to this aspect of the problem that attention has mainly been attracted in recent years.

The Nutritional Plane

In the dry tropics and sub-tropics, during a very large part of the year, the animal on open range must be content with a very inferior type of grazing made up of grasses that have already seeded and have been rapidly dried out by the sun. Moreover, the grasses that thrive or survive under such conditions are generally inferior species, poor in leaf, low in protein, and, after seeding, high in fibre content and deficient in vitamins. It has been suggested that the standing grass of these dry hot areas, when dried out by the sun after seeding, is of higher nutritional value than the better grasses of the higher moisture areas under similar conditions. That may be so, but there can be no doubt that under arid conditions even native Zebu cattle progressively lose condition during the dry season and, where conditions are exceptionally severe, native cattle may die in large numbers. Over a large part of Africa this energy deficiency has superimposed on it a phosphorus deficiency, which leads to dystrophic bone diseases and such conditions as lamsiekte. There can be no shadow of doubt that, in such an environment, that is to say in an environment in which native cattle lose condition badly during each dry season, grade cattle or purebred European cattle will suffer much more severely, and will rapidly deteriorate with successive generations.

It will be evident that these nutritional handicaps will exert their effects chiefly on the ranch beef herds, and indeed it is in the ranching industries of Southern U.S.A., Queensland, Northern Australia, Southern Rhodesia and the Union of South Africa that this progressive degeneration of European beef cattle has been chiefly observed. In Southern Rhodesia and the Union, the high grade herds of Sussex, Shorthorn and Angus cattle are now being crossed with the Afrikaner, a humped animal with Zebu characteristics.

In Kenya we have in recent years seen a steady expansion of the practice of ranching native Zebu stock or of lowering the percentage of European blood by successive back crosses to the indigenous Zebu.

So far as the milk herds are concerned, intensive dairying is of necessity carried on in the less arid and more fertile parts of the Colony, where grazing is of better quality and fodder crops can be grown, and cattle are unlikely to suffer from these nutritional handicaps. But in the less fertile, less developed areas of this Colony, there is still a good deal of the so-called ranch-dairying with grade cows. The ranch-dairy herd in the dry season, and particularly in years of drought, will suffer from energy and mineral deficiencies even more severely than the beef herd in a similar environment, for the dairy cow will always draw on her own skeletal reserves of minerals before milk production ceases, and when finally she is dried off she will be in much poorer shape to withstand a further period of semi-starvation than the less productive beef cow. The young stock, too, of the ranch-dairy herd will generally be much less well nourished than their counterparts in the ranch-dairy herd, and they will be weaker as a result of sublethal attacks of such diseases as redwater, anaplasmosis, paratyphoid, necrosis and minor digestive ailments. Heifers which during the first 18 months of their lives are exposed to the rigours of a severe dry season, while still suffering from the after-effects of these illnesses, will, if they survive at all, usually be stunted and unthrifty for life, they will never grow into strong heavy cows of robust constitution. Experience in Kenya during the last ten or fifteen years has done much to expose the weakness of the ranch-dairying method, and in the drier and less fertile areas this particular system, which has many disadvantages, is gradually being abandoned in favour of beef ranching, while in the more promising areas it is giving way to a more intensive system of dairy management in which the production of fodder crops plays an increasingly important role.

Resistance to Disease and Parasitic Infestation

Much has been written of the inability of the high-grade animal introduced into the tropics to resist sublethal infections with common enzootic diseases of indigenous stock. The diseases that are generally supposed to be of greatest significance in this connexion are the less fatal tick-borne diseases—redwater, ana-

plasmosis, and infections with *Theileria mutans*, the common small piroplasm of Central and South Africa. In this group of diseases, infection is normally contracted in the first few weeks of the calf's life, and it is a well authenticated fact that the severity of an infection or the susceptibility of the animal increases directly with increasing age of the host. We have had occasion, in the investigation of calf diseases, to follow the course of infection to recovery or death in a number of herds of grade cattle in this Colony. Under the best conditions of management, but in the absence of any effort to protect calves from infection by the vector ticks, hand-reared and stabled calves apparently acquire infection when they are from 4 to 7 weeks old, and the first symptoms of illness are noticed when the calves react to *Anaplasma marginale* at from 10 to 14 weeks of age. In calves that have been making a satisfactory gain of approximately 1 lb. per day, it will be found that at about this time the calf will suddenly cease to gain, and may even lose weight, for from 2 to 4 weeks. Examination of the affected calves will reveal fever, usually not very high, some degree of anaemia or even jaundice of the visible mucous membranes, and perhaps a tendency to be constipated and to become blown after feeding. Blood smears show *Anaplasma marginale*, and more or less marked anaemic changes, depending upon the severity of the attack and the stage reached. Most of the animals will make an uneventful recovery in the course of 2 or 3 weeks, but a small percentage will die at the end of a similar period, and at the time of death it will often be found that there has been a relapse to redwater infection in the final stages of the attack of anaplasmosis.

This is the mildest form of redwater and anaplasmosis ever noticed in calves in this country, but of course in mildness it will be surpassed by the inapparent infection through which the calves of the low-grade or native ranch-dairy herd will pass completely undetected. In the less efficiently managed ranch-dairy herd, the symptoms of these infections may be much more marked; the mortality, the after-effects in recovered animals, and the exacerbating effect on the other intercurrent diseases and minor ailments to which calves in such herds are subject, will considerably increase the wastage rate.

It has been repeatedly claimed by observers in different parts of the world (e.g. Southern United States, West Indies, the tropics of

Australia) that frequently recurring sublethal attacks of redwater and/or anaplasmosis are mainly responsible for the unthriftiness and degeneration of both beef and dairy cattle in the tropics.

It is, of course, recognized in Kenya that the grade or purebred animal is unquestionably more susceptible than the local Zebu races to all the indigenous tick-borne diseases, and that this higher susceptibility is manifested in the greater severity of attacks and the higher mortality rate among the attacked, whether calves or adults; but beyond that conclusion we are at present unable to go, although in the higher country where dipping is often neglected we have occasionally seen unthrifty animals suffering from sub-clinical infections with redwater and anaplasmas at an age well beyond that at which they ought to have acquired a serviceable immunity.

A great deal of significance has been attached in the same countries to what is known as "tick worry". This is a term used to denote the general systemic effect (apart from the transmission of disease) of excessive tick-infestation, to which it is alleged grade animals are peculiarly liable. It is stated that the steady drain of blood by the parasites and the irritation from their punctures may together reduce the high-grade or pure-bred animal to an anæmic and debilitated state. On the other hand it is claimed that Zebu cattle or grades carrying a certain proportion of Zebu blood appear to be relatively resistant to tick infestation, in that one does not find excessive numbers of ticks on them, nor do they appear to suffer at all from the loss of the blood that is extracted by the parasites. Our experience in Kenya suggests that in so far as the blue-tick group is concerned the claim may very well be correct, but with reference to the other species which are even more numerous in East Africa, the inferiority of the grade animal is certainly less well marked, if it exists at all.

Excessive infestations with blue ticks are seen only in the high areas above the east coast fever line, where many farmers fail to dip their cattle regularly. Ranching, on the other hand, is generally carried out at low altitudes on the lighter soils. The soils and the climatic conditions in the ranching areas are not so suited to the brown-tick group as the moister and more fertile forest loams and red soils of the "dirty" areas; on much of the ranching country the predominant tick is *Rhipicephalus pulchellus*, although *Amblyomma variegatum* (the bont tick) and

Hyalomma species (bont-leg ticks) do occur. Dipping on such ranching lands may be carried out at 14 day intervals, or may be desultorily applied, except when the introduction of east coast fever makes it necessary to control the infection by a spell of short-interval dipping. Under these conditions tick infestation never appears to reach the point at which "tick-worry" is noted.

Since the intensively managed dairy herd below the east coast fever line will always be regularly dipped and will be grazing an area sufficiently limited in extent to ensure that ticks on the land will rapidly be reduced to low proportions, the question of "tick worry" will not arise. The blue tick is the first group of species to disappear under short-interval dipping, and "tick-worry" in Kenya is in consequence only to be seen in the high areas already mentioned, where dipping is rarely carried out.

With regard to the trypanosome infections, the grade animal is again clearly more susceptible to trypanosomiasis than native Zebu stock, in that the course of the disease is much more rapid and acute in the grade animal. Nevertheless the advantage of the Zebu or low-grade animal in this respect is more apparent than real, since the infected Zebu sooner or later, when exposed to unfavourable conditions, will succumb to a trypanosome infection which it was able to resist as long as conditions were favourable.

There remain two virus diseases to be considered in this connexion—rinderpest and foot-and-mouth disease. Here again there can be no questioning the fact that the grade animal is much more susceptible to rinderpest than the Zebu; but since rinderpest is subject to general and close control wherever grade cattle exist, the difference in susceptibility to this disease is of little or no practical significance. Unfortunately one cannot say the same of foot-and-mouth disease, to which grade cattle show a markedly greater susceptibility than Zebus, as manifested by the greater clinical severity of attacks, the mortality in calves, and the greater frequency with which such sequelae as deep-seated muscular abscesses and the "woolly-coated" condition occur. Control of the spread of foot-and-mouth disease is by no means satisfactory, and there is no practicable method of vaccination that might be economically applied at present in this country. We must conclude that in respect of resistance to this particular virus, the grade animal is at a considerable disadvantage.

Direct Effects of Tropical Climates on the Heat-Regulatory Mechanism

During the last four or five years there has been a certain amount of investigation of the physiological effects of exposing cattle to high atmospheric and sun temperatures. This particular field of research has been ably pioneered by such workers as Rhoad, Regan and Richardson, and one or two others. More recently there has been a perhaps somewhat precipitate tendency on the part of other workers in animal husbandry to ascribe the degeneration of European cattle in the tropics almost entirely to the direct effect of high atmospheric temperatures. These studies on the heat-regulatory mechanism are as yet in their infancy, and it is only fair to say that many of the conclusions have been coloured by the results of similar investigations that have recently been made into the heat-regulatory mechanism of man in hot climates. In order properly to appreciate the value of the data so far gathered, it is necessary to give some little consideration to the facts that are known about heat regulation in man and the domestic animals.

On the whole, man has succeeded remarkably well in adapting himself—with certain artificial aids—to residence in tropical climates. His normal method of dissipating the heat that is produced by the ordinary physiological processes of metabolism—or by the performance of work which raises the rate of metabolism—is by conduction and radiation from the skin, by the evaporation of water with the air expired, and by the evaporation of water transpired through the skin. The last is the so-called insensible perspiration, but in fact the passage of this water through the skin is entirely unconnected with the functioning of the sweat glands. When man is exposed to high atmospheric temperatures the evaporation of water is greatly increased by the onset of sweating. The heat abstracted by vaporization of large quantities of water on the skin surface cools the skin, and to take advantage of this the blood circulation of the skin is greatly increased, so that larger volumes of blood can be cooled. This particular mechanism functions remarkably well, but it is not perfect. One disadvantage is the excessive loss of chloride in the sweat; it is true that in people acclimatized to high temperatures the concentration of chloride in the sweat is reduced, but the occurrence of heat cramps in manual workers during hot weather is evidence of this particular handicap. When man loses much chloride in this way his weight cannot be restored until the chloride loss is

made good, when he will be able to retain sufficient water to restore his weight to normal. A second disadvantage is the diversion of a considerable quantity of arterial blood from its normal purpose, i.e. oxygen transport, to assist in cooling by increasing the circulation through the skin. This means that the heart rate must be accelerated in order that the remaining blood can travel more rapidly through the lungs to receive its load of oxygen and distribute it to the tissues. It also means a fall in blood pressure owing to the dilatation of the skin capillaries. In patients with weak hearts, fainting fits are liable to arise from this combination, and in general heart troubles are perhaps the most noticeably increased of the non-specific organic diseases in very hot climates.

When the heat-regulatory mechanism of man or any other warm-blooded animal is inadequate to cope with its task, the body temperature rises and considerable discomfort is experienced as long as the subject is in a fevered condition. This phenomenon is not uncommon in the tropics before acclimatization has been effected, or during sudden heat spells or intensely hard muscular work in winter in temperate countries. Man's capacity for hard muscular work is limited by the capacity of his heart to pump sufficient oxygenated blood to the tissues; it will obviously be less as the environmental temperature rises.

The heat-regulatory mechanism of equines is very similar to that of man. Sweating is the main means of dissipation at high temperatures, but apparently no chloride is lost, and after considerable sweating the body weight is at once restored by water and ordinary feed.

The dog, on the other hand, reacts to high atmospheric temperatures quite differently. At low temperatures the dog loses heat by conduction and radiation from the skin, by evaporation of water at the lung-air interface, and presumably by transpiration of water through the skin. As the atmospheric temperature rises these means are insufficient to maintain a balance unless the animal is completely at rest. The skin of the dog is unprovided with sweat glands except on the muzzle and pads of the feet, so increased evaporation of water is obtained at the lung-air interface by panting, that is by a greatly accelerated rate of respiration. The heart rate is slowed down, and to counteract the effects of over-ventilation the dog, according to Dill, seems to be provided with the special facility of reducing the partial pressure of CO_2 in the blood to

about one quarter of its normal value. The advantages of the dog's cooling mechanism are that there is no additional strain on the heart, since the aeration of blood is carried on at the same surface as the cooling; he creates his own air movement by panting, and is not dependent as man is on air currents for comfort; and finally there is no chloride loss from sweating and no loss of weight that cannot be restored by water and food. The great disadvantage is a dry skin which may reach an exceedingly high temperature in the sun, with absorption of considerable heat into the blood stream. The dog's heat-regulatory system is not so efficient as that of man, particularly when he is called upon to perform muscular work at high temperatures, and his capacity for work generally is limited by his capacity to dissipate heat. Most veterinarians are familiar with the fluctuations in body temperature of normal dogs in summer time. Accordingly the dog can do much more work in cool conditions than in a warm environment.

Turning now to cattle, the investigations of various observers have shown that at low temperatures the ox dissipates heat in the usual manner, that is by radiation and conduction from the skin and by vaporization of expired water and water transpired through the skin. At low temperatures the main loss is through radiation and conduction, but as the atmospheric temperature rises above what has been termed the critical point, i.e. the point at which the heat loss of a resting animal exactly balances the heat production, the loss by evaporation, first of the water transpired through the skin and then of water at the lung-air interface, is proportionately increased. The cow is not a mouth breather, but none the less the rate of respiration increases with the rising atmospheric temperature until the animal virtually pants. It has been stated by Regan and Richardson that the increase in the respiration rate with a rising atmospheric temperature follows the law of chemical reactions in that the rate doubles for every increase of 18°F . Direct observation, however, shows that under outdoor conditions at high temperatures there are considerable fluctuations in the rate of respiration. Successive observations taken at intervals of a few minutes may show great variations; at one moment a Zebu cow may be breathing 40 times a minute and a few moments later the rate may be 70. It is possible that control is exercised by the animal in response to a

sensation of comfort or discomfort. The pulse rate tends to slow down with the increase in respiration rate, which is what one would expect.

With continued increase of the atmospheric temperature the animals may show signs of distress, and there may be drooling of large quantities of saliva and a rise in the rectal temperature: the mechanism has in fact failed.

Sweating as a means of heat regulation is not ordinarily called into play, although the skin is fairly well provided with sweat glands, and sweating is not uncommon in certain pathological conditions. The physiology of sweating in cattle requires further investigation.

It will be evident that the heat-regulatory mechanism of cattle, so far as it is understood, is almost exactly like that of the dog, and that it suffers under the same great disability—that of a dry skin which may reach such a high temperature that considerable heat is absorbed by the circulating blood.

Working with cows of European breeds, Regan and Richardson have shown that under controlled conditions of temperature, humidity and air movement, and with periods of five days' continuous exposure, the heat-regulatory mechanism of cows of European breeds fails to hold the rectal temperature constant when the atmospheric temperature is over 70°F . at 60 per cent saturation. At this temperature, the rectal temperature of the animals will rise on an average 0.3°F . These experiments were carried out in a psychrometric chamber, and no mention is made of the time of the year or the state of the animals' coats, both very important points, since earlier experiments have shown that the effect of clipping an animal carrying a winter coat may be to raise the critical atmospheric temperature for a fasting animal by as much as 11°F . The effect of sudden exposure to high temperatures during winter has frequently been demonstrated in observations on man; the heat-regulatory mechanism is apparently unable to meet the demands made upon it by a sudden change to summer conditions. In Regan and Richardson's experiments the temperature of the cows rose to 102.2° at 85° , and to 103.7° at 95° , and the respirations increased to 59 and 57 per minute respectively. It is to be emphasized that these temperatures were maintained throughout each period of 24 hours, and there was no respite in which the animal might regain its balance.

At temperatures exceeding 80°F., there was a fall in milk production which was not very marked until the temperature reached 85° to 90°, a fall in the percentage of non-fatty solids, a rise in pH., and a delayed coagulation time.

In another paper, Regan and others have shown that spraying with fly-repellents of an oily nature lowers the pyrexial point, that is the atmospheric temperature at which the rectal temperature begins to rise, by roughly 5°, thus indicating the relatively important part that is played by the transpiration of water through the skin as atmospheric temperatures rise. These workers concluded that the upper limit of the capacity of the European cow to maintain efficient heat regulation lies between 80° and 85°F., depending on the breed.

Comparative Investigations in European and Zebu Cattle

Rhoad (1938) has shown that there are quantitative differences between Zebu cattle and European cattle in their response to high atmospheric temperatures. He studied four cows: one Angus, one three-quarter-bred Angus-Zebu, one half-bred Angus-Zebu, and one pure-bred Zebu, and observed an increase in respiration rate with a rise in atmospheric temperature. The increase was greatest in the three-quarter and pure-bred Angus, and much less in the half-bred and pure-bred Zebu. With the rise in temperature there was a relatively large increase in the quantity of water transpired through the skin in the Zebu and the half-bred Zebu, and when the temperature reached 86° to 95°F., the amount transpired in a given area reached double the amount similarly transpired by the three-quarter and pure-bred Angus. There was a decrease in the

concentration of urine with increasing temperature in the grade animals, and a slight increase in the Zebu. At shade temperatures between 86° and 95°F., with the animals in the shade, the rectal temperature of the pure-bred animal rose to 102.8°, but in the other three animals the rectal temperature failed to reach 102°. At the same temperatures but in the sun, the pure-bred Angus rose to 107.4°, the three-quarter bred to 105°, while the half-bred animal barely passed 102° and the pure-bred Zebu still remained below 102°. Similar results have been recorded by Bonsma and others, while French of Tanganyika has recorded increased respiration rates for grade over Zebu cattle.

In Tables I and II below there are summarized the results of a number of observations carried out by Dr. J. Anderson on grade and native cattle in Kenya. In Table I, a comparison is given between pure Zebu, ordinary medium dairy grades (mainly Ayrshire), and pure-bred Aberdeen Angus at Naivasha. In Table II the comparison is between pure Zebu cows, low-grade Shorthorn, and high-grade Shorthorn cows raised in one of our high and colder zones, and it was carried out at Muhuroni under warmer conditions. The animals under observation were grazing normally, and it is possible that the Muhuroni figures for the grades are a little on the high side owing to the nervousness of the cows under handling. It will be observed that under natural grazing conditions the heat-regulatory mechanism of the grade cattle allows the rectal temperature to rise above 102° once a shade temperature of 70° is passed. This is roughly in conformity with the results recorded by Regan and Richardson, although in the present observations the animals were out of doors and free to choose sun or shade.

TABLE I
EXPERIMENTAL STATION, NAIVASHA
JUNE, 1941

Shade Temperature	Saturation Deficit	Body Temperature			Respirations per Minute		
		Zebu	Grade	Angus	Zebu	Grade	Angus
51-55	3.2	100.8	101.1	100.9	21	27	30
56-60	2.0	101.2	101.2	101.6	23	25	35
61-65	4.3	101.4	101.7	102.3	25	34	38
66-70	5.2	101.6	101.9	102.5	29	37	45
71-75	9.3	101.7	102.0	102.9	34	39	51
76-80	10.8	101.7	102.2	103.1	35	44	56

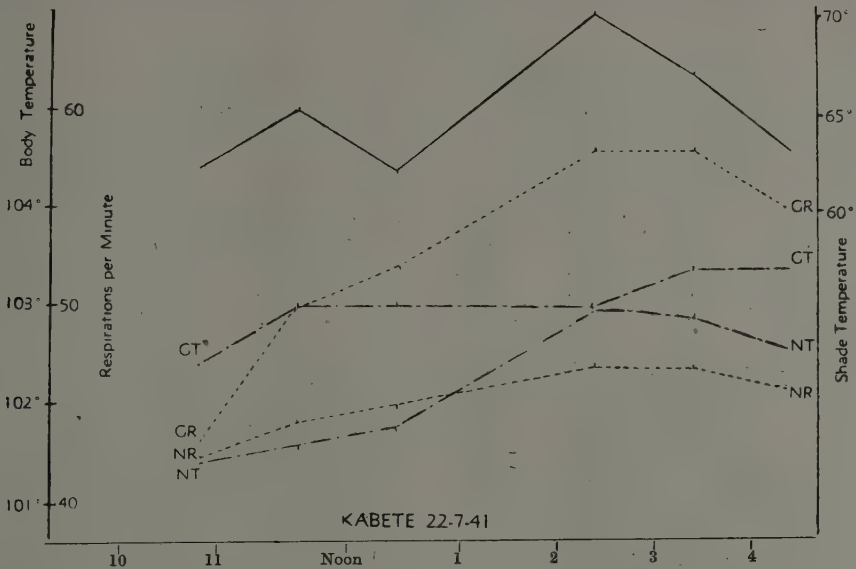


FIG. 1

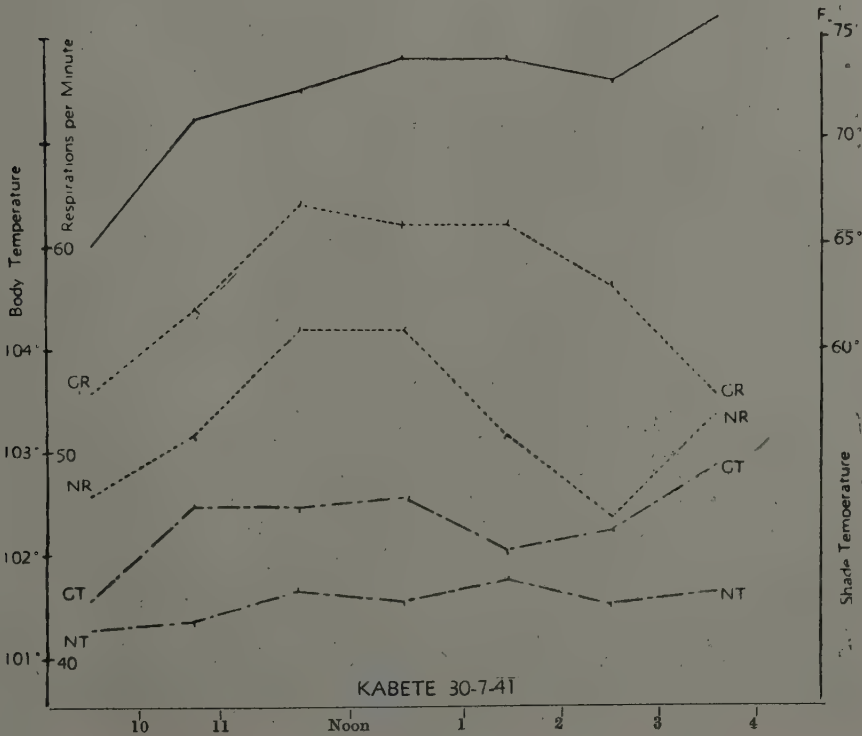


FIG. 2

TABLE II
MUHURONI—JULY, 1941

Shade Temperature	Saturation Deficit	Body Temperature			Respirations per Minute		
		Zebu	Low-grade	High-grade	Zebu	Low-grade	High-grade
61-65	2.4	101.1	99.9	101.1	20	27	35
66-70	3.0	100.2	100.4	101.7	26	37	66
71-75	7.8	101.2	101.8	103.9	20	50	87
76-80	10.0	102.1	102.8	104.9	51	76	106
81-85	13.0	102.7	103.3	105.5	58	77	131

The graph, Fig. I, taken from Mr. Hudson's observations, shows the relationship between shade temperature, respiration rate and body temperature during the course of six hours of a warm day at Kabete in July, our coldest month. The animals are medium-grade Shorthorn steers and pure-bred Boran native cows. Fig. II shows a similar record of observations on the same animals on a warmer day a week later. Points of interest are the difference in the response of both grades and Zebus on the two days. On the cooler day the sharp rise in shade temperature to 70° in the afternoon brings the temperature of the grade cattle up to 103.4° at 4 p.m., and that of the natives to 103° at 2.30 p.m., the respiration rate of the grades reaching 58 at 2.30 p.m., the hottest time of the day, and that of the natives 47 at the same hour. On the warmer day of the 30th July, during which the shade temperature was above 70° for five hours, the mean rectal temperature of the grades does not reach 103° until 4 p.m., and the temperature of the natives is below 102° throughout. On the other hand, there seems to have been a compensatory increase in the respiration rate, for that of the grades is over 60 for three hours and that of the natives over 50 for much the same period. These charts have been reproduced to illustrate the variability of response to moderately high temperatures on different days: the lowering of the body temperature by accelerated respiration: and the fact that at Kabete where high-grade Shorthorn cattle certainly do not degenerate, a moderately warm day may be responsible for a rise in rectal temperature to 103° in native cattle and something over that figure in grades. To what extent such evening rises in temperature are harmful is a matter for further investigation, but again it is a matter of common knowledge to anyone who has carried

out tuberculin tests of the old type, that evening temperatures of between 102° and 103° are by no means uncommon in stabled animals in winter in Northern Britain.

Provided an animal's temperature returns to normal soon after sundown, too much attention need not be paid to afternoon rises. At the same time, it will be evident from a consideration of these facts that high atmospheric temperatures do put a greater strain on the heat-regulatory mechanism of cattle of the European breeds than on that of the Zebu animal. There are obvious explanations for this difference, the greater bulk of the grade animal in relation to its surface area, the absence of the loose skin of the dewlap and sheath, the smallness of the ears, all reduce the area of the cooling surface. The greater bulk and higher productivity of the grade demand a greater supply of food and a higher level of metabolism, with more heat to be dissipated. The longer, coarser coat of the grade offers a greater resistance to air movement (although this may be an advantage at extremely high temperatures) and in this respect the finer-skinned and shorter-haired of the European breeds are superior.

The demonstration of these quantitative differences between the responses of the heat-regulatory mechanism in European and native breeds has opened up a most promising field for investigation. There are, however, other approaches to the problem, and one of them is the study of blood components in European and native animals. In the Philippines the importation of European breeds has been a signal failure; and recently Manresa and his colleagues have shown that the haemoglobin content of the blood in imported Friesland and Hereford cattle is considerably lower than that of native animals or Indian Zebus. Their

figures for Hereford and Friesian animals are 6.76 and 6.88 grams per 100 cc. respectively, while native and Indian cattle had figures of 9.43 and 9.87 grams respectively. They conclude or assume that the temperature of the air is the most important factor affecting the ability of European and American animals to become acclimatized in the Philippines, and characterize the lowering of the haemoglobin content as one of "the changes in physical and chemical composition of the blood that have been instituted to facilitate disposal of body heat"; but no evidence is offered in support of the last contention. It is, of course, possible that the lowered haemoglobin index is directly related to the heat-regulatory system, and that it might be a method of avoiding over-ventilation during panting, but that is a matter for further investigation. On the other hand, nothing is said of the blood protozoan parasites of which the subjects of the experiments may have been carriers. As a matter of interest, Table III is reproduced to show the relative haemoglobin concentrations of dipped grade and native cattle at Kabete. They indicate that whatever were the conditions responsible for the low figures in the imported animals in the Philippines, they do not operate at Kabete.

TABLE III

SUMMARY OF HAEMOGLOBIN DETERMINATIONS
AT KABETE

TYPE	Number exam- ined	Average Hb value
SHORTHORN GRADES—		
Cows in milk	12	9.74
Cows in calf	12	10.02
Heifers	6	9.96
Calves over 6 months..	5	8.39
Calves under 6 months	13	9.48
NATIVE CATTLE—		
Work oxen	8	8.83
Native cows	12	8.97

A lowered fertility is generally regarded as one of the characteristic signs of degeneration of European breeds in the tropics. In Kenya we have remarked many cases in which rams imported from England have failed to serve, and ewes have not shown oestrus. This phenomenon is commonest in the mutton breeds, which experience a prolonged period of anoestrus each year, and it is in all prob-

ability related to the absence of marked seasonal climatic changes. But in imported cattle no such suppression of sexual activity has been observed, although under good conditions of management the grade animal in Kenya is a less efficient breeder than the native, requiring on the average 13.3 months to produce a calf against 11.4 months for the Zebu. To what influences this difference should be attributed is as yet uncertain.

General Observations and Practical Experience

There are records of a number of investigations that have been framed on more general lines, with a view to demonstrating differences between European and Zebu cattle in tropical and sub-tropical regions; and a good deal may also be learnt by referring to the practical experience of stock-farmers in these countries.

Ranching, for example, has been in progress in the Southern United States for something like 140 years, and since the continent was without indigenous cattle it was originally stocked up mainly with animals of British breeds. Indian Zebu cattle were imported into the Southern States as long ago as 1849, and again in 1882, but according to the records of the U.S. Bureau of Animal Industry, most of the cross-bred Zebu cattle in the Southern States to-day derive from an importation made by Borden in 1906. Borden noticed that Hereford cows on his Texas ranch had "run out" to about 780 lb. live weight, in spite of the regular use of the best pure-bred bulls that could be bought. After some preliminary experiments with Zebu crosses, he obtained special permission to import 33 Indian Zebu cattle, and afterwards he maintained a stud herd from which Indian blood was distributed to the Gulf Country.

For many years now it has been the practice of ranchers in this Gulf area to maintain a certain proportion of Zebu blood in the herds, and although the steers from the Zebu-graded herds are not so popular with the meat packers as those of the best British breeds, they have been freely accepted by the packers. It is stated by ranchers, veterinarians and others engaged in the industry that cross-bred cattle do better than the pure British breeds under such adverse conditions as drought and poor grazing, that they are able to travel long distances to and from water without loss of condition, and that they harbour fewer ticks than the European cattle.

The experience of the King Ranch in Texas is most instructive. This ranch, the largest in

the United States, was founded in 1854, and to-day extends to about a million and a half acres. For 35 years Hereford and Shorthorn cattle were bred pure on the estate, and in spite of the constant introduction of the best obtainable bulls, the cattle steadily deteriorated, the calving rate fell at times to as low as 30 per cent, and the live weight of the cows dropped to about 600 lb. From the use on a herd of Shorthorn cows of a half-bred Indian-Shorthorn bull that had been presented to the estate, it was realized that the infusion of Indian blood into the herd had brought about a considerable improvement, and it was eventually decided to experiment on a larger scale. Fifty-two Indian bulls were bought from Mr. Borden, referred to above, and mated to 2,500 Shorthorn cows. From a mating of one of these bulls (7/8 Nellore (Ongole)—1/8 Shorthorn) with a Shorthorn cow carrying 1/8 Indian blood (a grand-daughter of the original gift bull), an outstanding bull, Monkey, was obtained. Meanwhile six red bulls born from the first cross Zebu-Shorthorn were mated with 120 head of selected hybrid heifers, and of the calves from this mating 90 per cent were stated to be red and of a distinctive type. The bull Monkey was mated with 50 of the best of these red heifers, and from these beginnings the now famous "Santa Gertrudis" breed of red cattle has been developed, in the first place as a stud herd to breed males for crossing on the remaining Shorthorn and Hereford cows. The female progeny of this cross is again bred to the Monkey bulls, and it is stated that the F^2 generation is better than either the parents or grand-parents on either side.

In studies carried out at the Jeanerette Station of the B.A.I. in Louisiana on the response of the heat-regulatory mechanism under conditions of high atmospheric temperatures, high relative humidity, and intense solar radiation, it was determined that the Zebu showed the greatest degree of heat tolerance, the pure-bred Aberdeen Angus the least, and the half-bred Angus about the same as the pure-bred Zebu; the Santa Gertrudis cattle were about midway between the Zebu and the pure-bred Angus.

In the past the degeneration of European ranch cattle in the Southern States has been attributed to the three main causes already mentioned: a low nutritional plane, lack of resistance to ticks and tick-borne disease, and poor tolerance of high temperature and intense solar radiation. Kelley (1932) has reported on the marked superiority of Zebu-

cross cattle at the Jeanerette Station in Louisiana, where nutritional conditions in the paddocks were excellent. This leaves only the disease-resistance and heat-tolerance to account for the superiority of the half or quarter-bred Zebus in the Jeanerette observations; and if we recall that in 1938 not one of the 64 counties of the State of Louisiana remained in quarantine for tick-infestation, it seems certain that tick-infestation and resistance to tick-borne diseases is not playing any part to-day in the degeneration of European range cattle in that State. In the B.A.I. Annual Report for the year 1938, it is stated that studies at Jeanerette have shown that on bright clear days, with temperatures of more than 80° in the shade, Zebu grade cattle utilized 74 per cent of the daylight hours in grazing, while the purebred Angus utilized only about 50 per cent.

In the year 1933, 19 Zebu animals were imported from the Southern United States into North Australia by the Australian Government, and the five experimental herds into which these animals were introduced now contain 5,100 of their descendants. The animals are ranches mainly on open range; and the system of breeding has been designed to produce a range of "percentage-blood" animals, by back-crossing the half-bred progeny of the Zebu and British cattle to the parental breeds. In a recent report the opinion is expressed that for the conditions of Northern Australia the quarter-Zebu animal bred by crossing a half-bred cow with a British bull is a much stronger and more vigorous animal than the quarter-bred produced by crossing a British cow with a half-bred Zebu bull. The view is expressed that probably the most favourable results will be obtained by concentrating the Zebu blood in the breeding herd and making the necessary dilution for market requirements by using British bulls as sires of the sale stock. The similarity of this policy to that followed by one or two of the older ranchers in Kenya should be noted. At least one successful breeder in Kenya made a point for many years of never having anything higher than a three-quarter-bred cow in his beef herd, and many good dairy cows have also been produced from this system of mating. It is worth noting that in the case of the Australian herds this plan involves a complete change-over from female stock of British breeds to a grade breeding cow, probably with 50 per cent of Zebu blood, in fact Australian ranching will go back to the position that obtains in the low-grade herds of

Kenya to-day. It is the aim eventually to establish in these areas a fixed breed with a suitable proportion of European blood, and it will be noted that the Australian breeders propose cheerfully to face the difficulties that lie in breeding from "grade" bulls, in the effort to establish a breed of beef animal suitable to the local environment.

The advantages of the Zebu and cross-bred cattle upon which the Australian reports lay most stress are their ability to withstand bad dry seasons, to browse upon the "top-feed" of shrubs and trees, and in the tick-infested ranches their tolerance to tick-borne diseases, their finer coats and comparative freedom from tick-worry. Little has been published concerning the comparative tolerance of Zebu and British breeds to high temperatures in Australia, but in the most recent report of the Council of Scientific and Industrial Research it is emphasized that "no recommendation is made that Zebus should replace British breeds in areas with a mean annual temperature of less than 68°F. and an average maximum temperature for the coolest month of less than 66°F."

Turning now to South Africa, we have the recent records of Bonsma and his co-workers, who compared the behaviour of the heat-regulatory mechanism of exotic beef cattle with that of the Afrikaner breed, in respect of respiration rate, rectal temperature and the dribbling of saliva. These observations were made at Messina, which has a mean annual temperature of 73°F., and they showed that, as far as heat tolerance goes, the Afrikaner cattle approximate in character to the Zebu, and that the purebred Angus, Shorthorn and Hereford react to high temperatures in the way that Regan, Rhoad, and others have recorded in America.

Bonsma has charted the location of the important breeding studs of Angus, Herefords and Shorthorns in South Africa, and has shown that in the main they are distributed in the belts that have a mean annual temperature of 65°F. or less. He points to the absence of successful breeding studs for the exogenous beef breeds in areas that have monthly maxima rising to 90°F. or higher, and concludes that in European cattle no degeneration will occur where the mean annual temperature is below 65°, or where average monthly minimal temperatures fall to 32°F. or lower.

The carefully controlled, long-range experiments of du Toit and Bisschop at Armoeds-

vlakte are likely eventually to yield the most useful information on the degeneration of European cattle under severe conditions in the Union. The experiments were started in 1925 to determine the effects of correcting a phosphorus deficiency in the diet in this area, and to use the words of the authors, "the results have proved that although the phosphorus deficiency apparently is the only limiting factor to normal function in indigenous grade cattle at Armoedsvlakte, it is but one of the many environmental factors affecting grades of exogenous breeds". The environment in question is made up of poor soils, and an average rainfall of 16 inches; for seven months of the year the grazing is dry, and even at the best period of the year it never approaches the normal for British grazing in protein or phosphorus content. There are marked seasonal and diurnal variations in temperature; the average maximum for January over 18 years is 99°F., and for July the corresponding minimum is 23°F.; the diurnal variation is between 41° and 57°F., evidence enough of the low moisture content in the soil. The crosses used were Sussex, Red Poll, Friesian and Afrikaner, and the foundation cows were the ordinary native stock.

The effect of the environment upon successive grades after correction of the phosphorus deficiency has been of much the same order in the three European crosses, though there are differences depending upon the functional adaptation of the breeds. The half-bred Friesians have been heavier, deeper and higher in the body than the foundation cows, and they have shown the milk conformation; the three-quarter-breeds have shown marked retrogressive changes in that they are shorter, narrower, and less deep in the body, and lighter in weight than the half-breeds, but have retained their height. The half-bred Sussex have shown great increase in weight and have become more compact, showing no increase in height, length or width; the three-quarter have retained their compactness but have been reduced in size and weight. The Red Polls have reacted intermediately and the half-breeds show the dairy type of change, while the three-quarters show the reduction in size of the beef type. The Afrikaner grades, on the other hand, show no significant deviation from the foundation stock in body weight or conformation. No conclusions have yet been drawn as to the factors in the environment that are responsible for the deterioration of exogenous cattle.

The experience in Jamaica with imported dairy cattle of European breeds is most instructive, since much of it has been carefully recorded over a long period by Cousins, the Director of Agriculture. The aim has been to provide a satisfactory liquid milk supply for the public services, and most of the work has been carried out at Hope Farm, Kingston. At one time or another excellent stock of most of the European dairy breeds has been imported for the Hope Farm herd, but the invariable experience has been that degenerative changes have appeared in the country-bred progeny of these imported animals. Redwater (*Babesia* infection) is said to have been introduced to the island about 1903, and there is no doubt that it has been responsible for a considerable wastage of both indigenous and imported stock. It has now been controlled to some extent by systematic dipping. For many years it was believed that sublethal infections with the redwater parasite constituted the main, if not the sole cause of the degeneration of the progeny of European imported stock; and in a review of the live stock industry of the island, Hammond (1932) assigns the major role to this infection, and a secondary role to nutritional deficiencies. Climatic influences are placed last in importance by Hammond, who assesses their effect as less than that of inbreeding. He does remark on the handicap suffered by those animals which showed a tendency to develop shaggy coats, and although he is inclined to attribute this tendency to the after-effects of attacks of redwater, he mentions that certain breeds which did best (Jersey, Red Poll) tended to maintain a fine summer coat all the year round, while others (Ayrshire, Short-horn) did not seem to have this ability. Assuming a reasonable amount of care to keep tick-infestation at a low level by dipping and grooming, such as we may reasonably expect under the Hope Farm conditions, it would seem to those of us with African experience improbable that redwater and/or anaplasma infections could have the serious effects ascribed to them in Jamaica, and much more likely that high atmospheric temperatures and high insolation are primarily responsible for the degeneration observed. The mean annual temperature at Kingston is 78.7°F., with a diurnal variation of about 16.0°F. only.

In an attempt to redress the failure of European cattle, Indian Zebu cattle of the Sahiwal breed were introduced for crossing with degenerate grade stock. Most of the

European dairy breeds are represented in the cross-bred or grade cattle of both sexes now in the Hope Farm herd, and the best cow in the herd a few years ago was a grade Friesian (18,030 lb. milk). Grade bulls are in use, but no attempt seems yet to have been made to fix a hybrid breed. It has been clearly shown that in this herd the crossing of degenerate European animals with Sahiwal or grade bulls has brought about an immediate restoration of constitution and milk production. In other words, the restoration of constitution by the infusion of Zebu blood has allowed the full expression in the progeny of an inherited capacity to give high yields of milk. That this effect is not to be ascribed solely to the vigour of heterosis is apparent from the performance of the F² and F³ generations.

Conditions in Kenya

Reference has already been made to the tendency that has been apparent during recent years among the ranchers in Kenya to lower the grade of their cattle, or even to revert to the ranching of pure native stock. To a large extent this policy has been prompted by the fact that in the past, ranchers have improved their cattle more rapidly than the pasture on which the cattle have to subsist. No doubt the expense of importing purebred beef bulls of exogenous breeds has also influenced ranchers in their decision, and in general, experience of grade bulls has not been favourable. Although ranching is carried on in the warmer and more arid parts of the White Highlands, the opinion has not been generally held that temperatures have been a deciding factor against high grading of beef cattle, nor has susceptibility to disease been regarded as highly important; in fact most ranchers of beef cattle in Kenya would point to nutritional conditions, particularly in drought years, as the cause of their preference for low grade and native stock, and the writer has formed the opinion that in stressing the nutritional factor they are probably right.

Reference to the report on a test of grade cattle carcasses made by French during the month of August, 1936, shows that grade cattle slaughtered at the Nairobi abattoir averaged 970 lb. live-weight and 538.9 lb. carcass weight. It is to be remembered that the majority of these grade animals were of dairy breeds and that all of them had come straight off the grass. In the same report there is a table of average weights of slaughter cattle during a period of 10 months for an estate

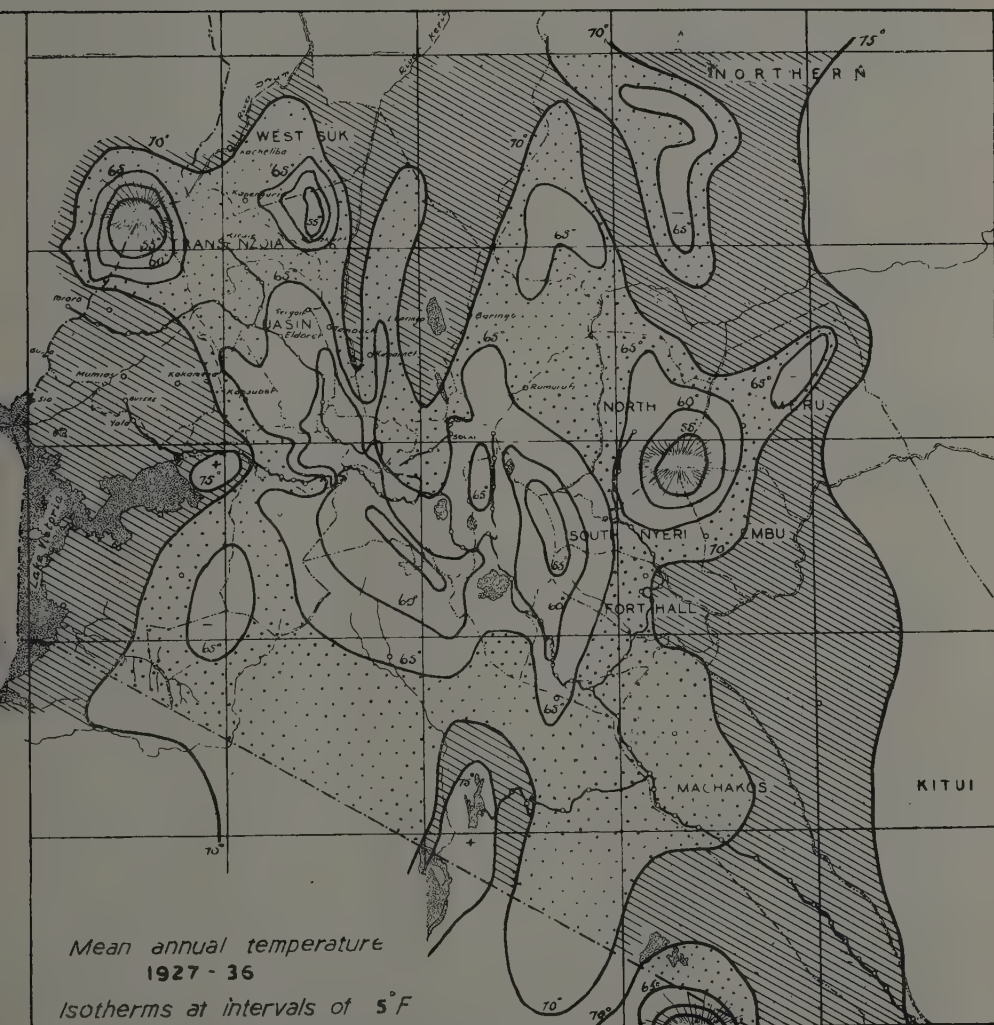


FIG. 3

with grade cattle, and 12 months for a ranch raising Boran Zebu cattle. The average carcass weight of the grades was 555.7 lb. and that of the natives 556.8 lb., but one consignment of 23 grade animals that included no animal over 36 months old averaged 549 lb., and in general the Shorthorn grades were about two years younger than the Boran cattle. In this case, both native and grade cattle came from the same area, which has a mean annual temperature of between 60° and 65°F., and it is evident from these records that no serious degeneration of grade cattle is manifested in that area.

Fig. 3 is a map of Kenya (kindly supplied by the Meteorological Service) on which are charted isotherms at intervals of 5°F., showing mean annual temperatures for a period of 10 years. It will be observed that in the main the areas that have been developed on the stock-farming side lie within the 65° isotherm, that is to say they have mean annual temperatures of less than 65°F. There are, however, exceptions to this general statement, and it will be noted that most of the Laikipia ranching country falls into the next higher zone—with a mean annual temperature between 65° and 70°F., and an erratic rainfall. This is one of the areas in which ranchers have shown a tendency to lower the grade of the herds or to revert to the ranching of Zebu cattle, and while some breeders apparently continue to do well with grade stock, there is need for a careful survey of results before any conclusion can be drawn as to the relative merits of grade or native ranch stock in this area. To the south-east there is another area lying between the 65° and 70°F. isotherms, in the Athi, Machakos, Kiu, Konza districts, that has achieved success with grade stock, and here there are prosperous grade dairy herds, but again some experienced breeders are turning to the ranching of native stock in parts of this area. Within the area enclosed by the 65°F. isotherm, we find districts such as Rongai in which there has been a rapid and successful change over to mixed farming with grade and purebred dairy cattle during recent years.

It is evident that the bulk of the country in which stock-raising by European farmers is already well established quite clearly conforms to the conditions which are regarded as suitable for European breeds in Australia, the Union of South Africa (Bonsma), and elsewhere, and its climatic conditions are above suspicion. In the case of the two exceptional

areas, there is need for further investigation of the effect of environmental conditions on grade and purebred European cattle, but on the whole it seems likely that the nutritional plane is here a more important factor than the direct effect of the slightly higher mean temperature.

Of the areas in which stock farming is at the moment being developed, or in which it is advocated that stock farming should be adopted, it will be seen that practically the whole of the Trans Nzoia lies between the 65° and 70°F. isotherms. If we apply the Australian and South African recommendations, this means that the climate in this area is probably a marginal one for grade and purebred European cattle, and local variations may be significant.

Leaving out of consideration the herds in the higher country of the slopes of Mount Elgon, which lies within the 65°F. isotherm, there is at least one large successful dairy herd of grade cattle (Red Polls) in the Trans Nzoia which shows none of the characteristic signs of tropical degeneration or loss of constitution; and there are many other smaller, more recently established herds, in which grade and purebred animals appear to be unaffected by climate. Other conditions make the district particularly suited to intensive dairying, but while the prospects for grade cattle seem favourable it would obviously be unwise to neglect the precaution of choosing for the district those European dairy breeds that, both in Kenya and elsewhere have shown the greatest tolerance for comparatively warm conditions, viz.: the Channel Island breeds, the Red Poll and Friesian, rather than such northern breeds as Shorthorn and Ayrshire. There will be many farmers in this area who will prefer to begin their dairy farming operations with the hardier native Zebu cows, and who may be well advised for some years to continue with Zebus while they are improving and developing their farms and acquiring skill in the management of a dairy herd. For such individuals it is evident that the imported Indian Sahiwal bull of high-yielding ancestry is the sire of choice.

These considerations have prompted the department to propose for the Trans Nzoia a breeding plan based on an insemination station which will maintain bulls of one selected European breed, and purebred Sahiwal bulls of the highest quality obtainable. This plan offers several advantages, and among them it gives the farmer an opportunity to

experiment for himself and from his own practical experience to decide whether grade or Zebu cattle are more suited to the particular conditions of his farm. If in the course of time his European grades show evidence of degeneration, or if only some particular lines show such evidence, he can make a back cross to Zebu without sacrificing the milk-yielding capacity.

Stock-raising has been largely advocated in recent years in two other areas that lie outside the 65°F. isotherm—Songhor-Muhuroni and Sotik. In the Songhor-Muhuroni area much of the country is on the hot side, and recent experience indicates that for the first few years the farmers in this area would be wise to use a Sahiwal bull to improve their native foundation stock. It is the intention of the department to establish an insemination station with Sahiwal bulls in this district. In Sotik it is possible that climatic conditions are more favourable than at Muhuroni, and here the department is establishing a station with grade bulls for the initial improvement, and the progress of the experiment will be carefully watched.

Summary

To sum up, it is evident that in a tropical environment purebred and high-grade cattle are liable, in the course of a few generations, to show retrogressive or degenerate changes. The factors responsible for this progressive degeneration may be related chiefly to the nutritional plane, to sublethal infections with certain tropical protozoan diseases, to excessive tick infestation, or to the direct physiological effects of high atmospheric temperatures and intense solar radiation.

It is probable that in Kenya such degeneration of high-grade stock as has been observed in ranches and dairy-and-rancher herds is largely referable to deficiencies in the nutritional plane, and that repeated attacks of red-water and anaplasmosis do not play an important or even a contributory part in most of the White Highlands.

There is as yet no evidence from the White Highlands that the direct physiological effects of climate *per se* have been in any way responsible for degeneration of purebred or grade cattle, indeed climatological data indicate that almost the whole of the areas where stock-raising is already established enjoys, as indicated by its mean annual temperature below 65°F., a climate of the type that is

regarded in other countries as eminently suited to the raising of cattle of the European breeds.

Two outlying portions of the main stock-raising area have mean annual temperatures above 65°F., but below 70°F., and are subject to rather erratic conditions of rainfall. These areas may be regarded as marginal for the raising of European grade cattle, but it is more probable that in these areas the low nutritional plane during drought years is a more serious handicap than the slightly higher atmospheric temperatures.

The Trans-Nzoia, Muhuroni and the Sotik districts are also marginal in respect of atmospheric temperatures. The progress of live stock raising should be carefully watched in these areas, and where grade cattle are utilized those breeds should be selected that display the greatest tolerance to warm conditions.

No great significance need be attached to small afternoon rises in body temperature or respiration rates as evidence of poor adaptation to climate; body form and weight and productive capacity, and the state of the coat will give more reliable indications.

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SOME NOTES ON THE MANAGEMENT OF THE MULTIPLE-STEM SYSTEM OF GROWING COFFEE AT THE LOWER ALTITUDES OF KENYA

By Major P. G. W. McMaster

All these notes are based on 16 years' experience at Donyo Sabuk, at about 4,800 ft., with an annual rainfall of 36.83 inches. The October, November and December rains are the more reliable, and of about equal precipitation to the "long rains"; there is usually useful rain in January or February.

Monthly averages over 26 years as follows:—

January	...	...	...	2.12
February	..	..	..	1.50
March	..	..	..	4.43
April	..	..	..	9.40
May	..	..	..	2.80
June	..	..	..	.66
July	..	..	..	.19
August	..	..	..	.27
September	..	..	..	.45
October	..	..	..	2.67
November	..	..	..	8.12
December	..	..	..	4.22

ADVANTAGES OVER THE SINGLE-STEM SYSTEM

- (A) Easier and cheaper pruning.
- (B) Easier regulation of crop.
- (C) Steadier cropping (less biennial tendency)
- (D) Less susceptibility to certain pests and diseases.
- (E) Higher average yield.
- (F) Bigger percentage of the higher grades.

To take all these factors seriatim:—

(A) *Easier and Cheaper Pruning.*—The principle of cutting the tree up, instead of selecting primaries and secondaries for removal, relieves the African of any mental responsibility; it can be done by a foot rule. The writer finds that from 4 ft. to 5 ft. of bearing wood per head is sufficient to yield 11 cwt. to 7 cwt. per acre, and he tries to regulate the carrying capacity to suit the particular plantation (*shamba*). He aims at four stems per tree, but with breakages, etc., the average is about 3.5 heads.

The pruner is given a stick, cut to the requisite length, which he pushes up until the top is level with the top shoot of the head; all primaries which originate below the bottom of the stick are removed (except as mentioned in note (L)—see diagram 1.

The same stick is then placed with its base on the ground, and if the tree is cut up more than the stick's length, the new suckers, if coming at a suitable spot—say from 9 in. to 2 ft. from the ground—are not all removed; usually one or two per stem are left—see diagram 1. If the tree is not yet cut up to the height of the stick, then all suckers are removed, except as later mentioned in note (M).

If it is found that some of the primaries remaining after the tree has been cut up are crowded with secondaries, these primaries are cut back to three strong secondaries.

It is found in practice that the task can be set at 75–100 trees per pruner boy-day, provided that the sawmen are a separate gang, moving behind the pruners.

The pruner decides what heads are to be removed, and the general principle they are selected on is that the new sucker has at least three internodes of brown bark, and that the old head is incapable of carrying its share of the crop. The pruner snaps off the top of the old head to indicate to the sawyer that it is to be removed.

The sawyer must cut obliquely to the new sucker at an angle of 45°, and must be neat and tidy; the writer always makes the pruners return along their lines, when the task is completed, in order to trim the cuts, in case these are left with strips of bark, etc., adhering.

In addition to the sawyers, a proportion of mallet and chisel boys are necessary, to remove heads in difficult places, trim old scars, etc.

The writer finds that, in average coffee, after an average crop, gangs of 20 pruners are the easiest units to work; his usual unit consists of one headman, 20 pruners, four sawyers and one chisel boy. In addition, he employs three "pundas" with pangas to lop the cut-off heads, leaving the loppings in the *shamba*, and carrying the stems to the *shamba* edge.

The sawyers must cut to within $\frac{1}{2}$ inch—(see diagram 3) in order that there shall be no dead wood above the junction; if this job is done well, it is extremely hard to find the original cut mark after four years—a slight thickening and bend in the stem being the only indication.

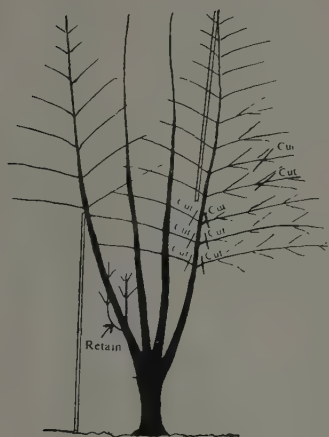


FIG. 1



FIG. 2

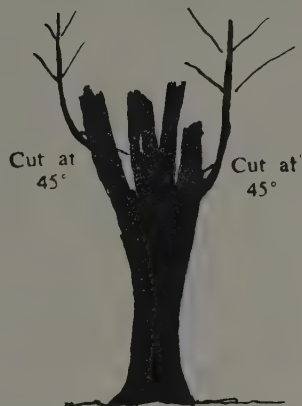


FIG. 3



FIG. 4



FIG. 5

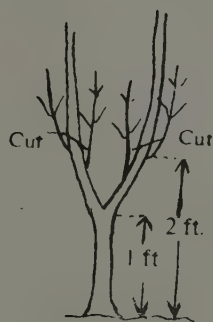


FIG. 6

When the trees have set their crop, a second run through by the pruners is necessary, for the purpose of de-suckering, and regulating the crop, if necessary.

The time to prune is immediately the crop is off; sickly trees can be left till the second time through, though there should be few of these if the previous season's pruning was well done. This at Donyo Sabuk is from August to October; the most suitable time for the second pruning is from January to March, and the task for this is usually about 250 trees per day.

(B) *Regulation of Crop*.—This is almost automatic if the pruning has been properly done; in exceptional seasons it may be necessary to cut the trees up slightly in January–March, to prevent over-bearing.

(C) *Steadier Cropping*.—This again is automatic. After a few seasons, trees will vary a lot, some being on the original cycle, on all heads, others half on a new one, others entirely changed to a new cycle; this ensures that there are no large groups of trees together, all cropping very heavily at once, and hence making enormous demands on the land all at one time, both for moisture and for food.

(D) *Less Susceptibility to Certain Pests*.—There is little doubt that both *Anestia* and *Thrips* dislike the more open type of coffee tree, and are always worst on thickly foliaged, shady coffee. This latter condition is not characteristic of the multiple-stem plantation. Further, the writer has a steadily growing conviction that *Hemileia* is much less troublesome on the multiple head.

(E) *Higher Average Yield*.—The writer can give no definite figures, since he has never had the handling of single-stem coffee where definite conclusions can be drawn. Nevertheless, he doubts if 220 acres in one block at Donyo Sabuk, on the single-stem system, would have given the results that the multiple-stem on this area has given over the last 10 years; i.e. over 9 cwt. to the acre since six years old, with a highest of 15 cwt. and a lowest of 5 cwt.

(F) *Bigger Percentage of Higher Grades*.—In a good season, with an average crop, the percentage of "A" grade right through the crop has been as high as 78 per cent; it has never been lower than 51 per cent. The writer attributes this to the crop being borne on younger wood than is the case in the single-stem system.

DISADVANTAGES COMPARED TO THE SINGLE-STEM SYSTEM

(G) Breakage from wind and picking.

(H) More difficult and expensive mealy-bug control.

(I) Unpopularity with pickers.

(J) Tendency to crop early, and in big flushes.

(K) Untidy appearance.

(G.) *Breakages*.—These are unavoidable, and usually frighten the newcomer to the system, but seldom in actual practice average more than .03 per cent of the heads. They can be largely eliminated by insisting on the pickers using a short crooked stick, with a few feet of string attached (see diagram 5); the crook is placed over the head of the stem, which is gently pulled down and the string given a turn round the picker's big toe. This enables the picker to use both hands, and prevents the sudden snatching which occurs when the picker turns round to engage his or her friend in light bandinage, and which is the most prolific cause of breakage. These sticks cost next to nothing, and are appreciated by the pickers, *once they are made to use them*, though they usually object to trying them at first.

(H) *More Expensive and More Difficult Mealy-bug Control*.—This is obvious. There are more possible passages for the ants; more banding grease is required, and it is not safe to keep the bands on the same place for more than 18 months. The writer considers that an undercoat of Melanoid paint, or some such substance is essential, owing to the thinner bark on the slenderer stems of the multiple head.

(I) *Unpopularity with Pickers*.—There is little doubt that pickers prefer to pick the same amount from the single stem than from the multiple; there is less reaching up and no chance of breaking. But in practice it will be found that by insisting on the use of the crooked stick, and by the fact that flushes are undoubtedly bigger on the multiple head, this unpopularity soon wanes. Pickers, when they find that they can pick more and are not being continually checked and punished for breaking trees, soon appreciate the fact.

(J) *Tendency to Crop Early*.—There is little doubt that in the Donyo Sabuk area the multiple-head system has changed the main crop from an August–December one to a May–July one. In fact on the writer's plantation 80 per cent of the crop is harvested between 15th May and 15th July, the bulk

coming off in June, when the flushes tend to be extremely heavy (on 10th June, 83 boy pickers averaged 6.8 4-gallon tins).

The writer is convinced that the coffee trade are inclined to hold off early crop coffees and persistently to regard all such as "fly" crop, and consequently of inferior quality. He has never had the courage to retain his small late crop, and to send it in the next season with his ensuing main crop, but he has often held back early crop, and sent it in to swell his later (and in his case "fly") pickings; in every case it has been classified higher than its equivalent, picked and cured a few months earlier!

(K) *Untidy Appearance*.—There is no doubt that a multiple-stem plantation presents a much less eye-pleasing spectacle than a single-stem one. It is right and proper that the trees should eventually be in different stages, and this does not make for symmetry, but it does ensure evenness of crop per year and per acre.

Some General Notes

(L) In order to eliminate breakages, the writer experimented when pruning by leaving an odd primary well below the others. This certainly stiffened the stem and eliminated some breakages, but not enough to justify complicating the pruning.

(M) Having found some difficulty in getting suckers to shoot where they are required (they tend to come either at ground level or several feet up the stem, where they commence to bend), the writer has been far less drastic of late years in removing such as do appear where wanted. Even if the tree is not cut up to the requisite height, such a sucker is not removed, but kept severely topped until wanted; it gets away at once, when it is allowed to grow—(see diagram 4).

(N) Converting the single to the multiple head. Many systems have been tried, but the only two that appear worth while, if some crop is required whilst conversion is taking place, are either the one which depends on the removal of all growth on one side of the stem, or the other which treats the original stem as a unit of a multiple-stem tree, allowing it to grow up, and cutting up. On the whole the writer prefers the latter; the former tends to produce a lop-sided tree.

(O) For a young plantation the writer is convinced that a first cycle on two heads is

the best, afterwards letting each head carry two more about 2 ft. from the ground. Hence, no tree carries four heads until it reaches maturity; it is asking too much to expect a tree to bear a full crop at five years old—(see diagram 6).

(P) If it is necessary to cut stems more than $1\frac{1}{4}$ inches in diameter, it is best to finish them off with a chisel, and to paint the wounds with Terrolas, to prevent decay setting in.

(Q) The length of life of a cycle is hard to lay down; many of the writer's trees are carrying odd heads at least eight years old. He does not see any advantage in changing a cycle for the sake of changing it.

(R) Never remove a head until a sucker has commenced growth below the point of separation; stems of suckerless and headless trees are too prone to remain so for several years, and may eventually die.

(S) Trees on good land will grow to a height of 14-16 ft.; with a crop these tall heads bend over well, and are easier to pick than stiffer 8-10 ft. heads, but they tend to sucker badly in their upper third.

(T) It is a good plan for the pruners to mark the trees which have "cracked" through overcropping with a splash of Terrolas on the main stem. This should be done in rotation yearly—on the north side the first year, east the second, etc.; any tree earning two black marks should come out; in 90 per cent of cases it will disclose a poor root system.

(U) Weeding tends to be heavier in multiple-stem plantations. The shade thrown by the trees is more distributed, and hence weeds grow right up to the stems. If weeds are treated as they should be—as a useful green manure—this is a point to the multiple-stem's advantage, but to-day, owing to chronic labour shortage, the advantage is more theoretical than real.

(V) Every saw-boy carries an ordinary pruning saw, and a keyhole saw for narrow places; foot lengths of band-saw, with some cloth wrapped round one end as a handle, answer perfectly well for the latter.

(W) It is best to buy good metal-socketted $1\frac{1}{2}$ in. or $1\frac{3}{4}$ in. chisels. They are expensive, but last indefinitely. Mallets the boys make themselves. It is as well to provide an oil-stone and a saw-set for the headman.

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THE PEOPLE AND THE LAND: SOME PROBLEMS

PART II

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THE PROBLEM OF LIVING STANDARDS

Costs of Living

Graham supplies the following monthly budget for a family of the clerk class at Bukura:—

Food—	Sh.	cts.
Sugar	2	33
Tea		76
Meat	2	81
Fowls		?
Oranges		04
Maize	1	33
TOTAL	Sh.	7 27

CLOTHING, ETC.—	Sh.	cts.
Clothing	4	79
Stockings		58
Blankets	1	08
Shoes		50
TOTAL	Sh.	7 95

CLEANING MATERIALS—	Sh.	cts.
Soap		44
Blue		16
Boot Polish		21
TOTAL	Sh.	81

MISCELLANEOUS—	Sh.	cts.
Books	1	21
Matches		08
Bicycle repairs		60
Hut Tax		1 00
TOTAL	Sh.	2 89

GRAND TOTAL .. **Sh.** **18 92**

Graham states: "Average costs, of the clerk class, when living here with their families, work out at some Sh. 250 per year, the greater part of which is expended on clothing and the least part on food such as tea, sugar, wheat flour, etc. Although so much is spent on clothes, they are hardly used here but only at their own homes. The labouring class, on the other hand, spends very little money at all beyond an occasional few shillings for shorts or a length of material for the family." T. C. Colchester, Municipal Native Affairs Officer for Nairobi, in a private communication, states that in July, 1939, the Divisional Engineer of the Kenya and Uganda Railways and Harbours, Nairobi, made investigations into the cost of living of certain railway workers, and concluded that the monthly disbursements on absolute necessities were as follows:—

	For a married man with two children	For a single man
Maize meal ..	Sh. 12 00	Sh. 4 00
Salt ..	10	10
Hut Tax ..	1 00	1 00
Charcoal ..	1 50	1 50
TOTAL	Sh. 14 60	6 60

Colchester goes on to say: "It should be noted that the diet allowed by these figures is very different from that supplied to some departments of the Railway. This diet is (per mensem):—

Maize flour	60 lb.
Salt	1 "
Beans	4 "
Choroko (Pigeon peas or gram)	4 "
Jaggery (Crude sugar)	1 "
Ghee (Butterfat rendered down)	4 oz.

This costs the single native about Sh. 6 and the married man with two children about Sh. 17/50 per month. . . . The Biological Chemist at the Medical Research Laboratory considers a reasonable diet for a native in Nairobi is as follows:—

	PER MONTH
Maize meal	37½ lb.
Maize, whole	7½ "
Beans	11½ "
Potatoes	11½ "
Meat	7½ "
Fat	1½ "
Sugar	1½ "
Tea, as required	
Vegetables	3½ "
Salt as required	
Milk	10 pints

The cost of this a month is about Sh. 11/50 for a single man and Sh. 30 for a married man with two children."

At the present time the cost of these food-stuffs would be in the region of Sh. 12 for a single man and Sh. 31/30 for a married man with two children.

The following diet table quoted by Norman [1] is adopted by the South African Railways for their native labourers. It includes 59 per cent of carbohydrate, 12 per cent protein and 28 per cent fat. The total caloric value is about 4,200 calories per man per day. The cost of this diet in South Africa is Sh. 12 per month

per man. It would cost about Sh. 18/50 for a single man in Kenya.

	Quantity per month	Lb. oz.
Food—		
(i) Protein—Meat	15	0
(ii) Fats—Lard, dripping	6	0
(iii) Carbohydrates—		
(a) Vegetables: Potatoes, sweet potatoes, onions, carrots ..	8	0
(b) Vegetables (green): Beans, green leaves, cauliflower, marrow, pumpkin, turnips ..		
(c) Vegetable (dried): Peas, beans	4	8
(d) Cereals: Maize meal, whole maize corn, rice, etc. ..	40	0
(e) Bread	8	0
(f) Sugar	1	12
(iv) Salt	14	
(v) Tea	6	

It will be noted that this ration is more generous in the matter of meat and fat, but omits the milk allowed for in the preceding Kenya diet sheet.

Other figures given by Colchester, as estimates only, are as follows:—

	Per month Sh. cts.
Clothing	2 00 to 3 00
Education	75
Soap	1 50
Amusements	1 00
Beer	1 50
TOTAL	7 75

However, Colchester writes that Davies, formerly Municipal Native Affairs Officer in Nairobi, considered a reasonable estimate of living cost of a married man with two children in Nairobi, in August, 1939, would be Sh. 38/25, made up as follows:—

	Sh. cts.
Food	15 00
Tax	1 00
Housing	7 00
Charcoal	2 50
Light	1 50
Soap	1 50
Milk	3 00
Clothes	2 00
Education	75
Drink	2 00
Tobacco	1 00
Amusements	50
Miscellaneous, bedding, furniture, cooking pots, bus fares, matches, etc. ..	50
TOTAL	38 25

At the time, food prices were high owing to a drought.

Rents

The men on the experimental units at Bukura do not pay rent at present, but probably it would be fair to debit the farmer with 10 per cent of the initial cost each year to cover repairs and amortization. This would

amount to about Sh. 18 a year, or Sh. 1/50 a month, for a great deal more comfort and privacy than the town-dweller enjoys. In the native location in Nairobi rents are as follows: Small room, Sh. 4 per month; double room, Sh. 6 per month; room occupied by two people, Sh. 7 per month; room occupied by three people, Sh. 9 per month. Privately owned rooms, designed for three people, "but frequently occupied by far more", are rented for Sh. 10 per month.

The following savings would be made by a Bukura farmer compared with a town native:

	Sh. cts.
Housing	5 50
Food	7 73
*Milk	3 00
*Charcoal	2 50
TOTAL	18 73

*Provided on the farm.

These savings would be additional to the monthly cash return of Sh. 50 to Sh. 80 for a farmer on six acres at Bukura. On the basis of Davies' estimates, the monthly expenditure of a family on a smallholding would be only Sh. 19/52 a month, while the smallholder would be able to provide a better diet, in accordance with the requirements considered necessary by the Biochemist of the Medical Research Laboratories, since he could procure ghee or butter, beans, potatoes, fruit and vegetables from the farm.

The figures for wages and costs of living which have been quoted by Colchester—the former will be given later—make it easy to understand why, as Colchester says, "It is a lamentable fact that, for economic reasons, the native in Nairobi is unable to afford to have his wife here." He gives figures to show that amongst natives in various classes of employment there are from one and a half adult males (amongst the general public) to every dependant, amongst the urban Africans, as compared with the one adult male to every three and a quarter or three and a half dependants, which is usual in the native reserves. From the foregoing figures, on the scale of diet deemed adequate by the Medical Department, it would seem that a married man with two children in Nairobi requires approximately Sh. 50 a month for all purposes, while a family living on six acres at Bukura could live on about Sh. 30 a month, plus the value of fuel, milk, fruit, vegetables, poultry and other food derived from the farm in addition to the commodities sold for cash.

Neither of these amounts for monthly expenditure represents a very high scale of life, however, though far ahead of that of the average African family to-day. The consumption of meat might be increased above the bare minimum. An expenditure of Sh. 3 to Sh. 8 a month on clothing is not lavish for a family of four or five. No allowance has been made for the purchase of extra luxuries, such as bicycles; yet the bicycle is as dear to the African as a means of visiting his distant friends and obtaining a rapid change of surroundings as the "jalopy" or old Ford car is to the poor white in the U.S.A. (107,548 bicycles were imported into Kenya and Uganda during the five years 1936-40.)

Little or no allowance has been made for any expenditure above the bare necessities of life; little or none for the purchase of books or any other concomitant of a higher cultural standard. What is certain, nevertheless, is that the African with some education is a good spender—this does not apply to the skin-clad primitive herdsman—and has a keen appreciation of good quality, whether it is in blankets, bicycles or clothing.

Graham's figures allow for an expenditure of about £6 a year on manufactured articles of local or foreign origin for each family of the clerk class. Davies's figures represent only about £3/10/0 a year per family. The former would represent about £4,800,000 spent annually on industrial products by Kenya natives if even the modest Bukura living standard was an average one; the latter standard, if an average, would enable only about £2,800,000 to be spent on other than agricultural products.¹ It is important, however, that the African should be able to support the arts and industries, not least in order to provide employment to those Africans who are surplus to the number which the land can support and to the number needed in town life.

African Incomes

Speaking of the income from experimental farm units at Bukura, Graham states: "A six-acre unit has shown a turnover of Sh. 600 a year." He considers that annual cash returns up to Sh. 1,000 may be expected from six acres—an area which he does not claim is necessarily the ideal farm unit, socially or

economically, for this region—largely by relying to a great extent on the cultivation of onions, a high-priced crop. In the figures he gives he takes no account of the value of vegetables, fruit, eggs or poultry consumed on the farm, though an estimate of the other farm crops eaten by the family is included.

How do these returns compare with those of Africans living in Nairobi, the hub of the East African universe? I am indebted again to Mr. T. C. Colchester for some very interesting figures relating to Nairobi Africans.

At the beginning of 1939, out of 28,243 Africans in Nairobi (out of the total population of 40,000), 6.3 per cent were earning up to Sh. 10 per month, 55.5 per cent from Sh. 10 to Sh. 20 per month, 32.1 per cent from Sh. 20 to Sh. 40 a month, and 6.1 per cent from Sh. 40 to Sh. 80 per month. These wages included the value of rations. Nearly 16,000 were receiving under Sh. 21 per month.

Since the outbreak of the present war, wages have increased considerably in Nairobi. African clerks with a good knowledge of English sometimes receive Sh. 100 to Sh. 150 per month, but it is evident that the average Nairobi native is not as well off as the successful farmer at Bukura, especially when the higher costs of living are considered. There are approximately 90,000 natives and 65,000 adult male natives in the municipal or township areas of Nairobi, Mombasa, Nakuru, Kisumu, Eldoret, Kitale, Nanyuki and Nyeri. This represents about 2.6 per cent of the estimated native population and 6.6 per cent of the adult male population of Kenya Colony.² The insufficiency of the land to yield anything but a miserable subsistence to the people in many localities must be held largely responsible for this, though it has been seen that town wages are not high, while expenses are much heavier and living conditions inferior to those obtainable with a little effort and enlightenment, where circumstances are favourable, in the country. The existence of a stable and peaceable society depends on the opportunities for reasonably remunerative employment in agriculture, commerce and industry being sufficiently nearly equal to the number of people seeking employment in these various sections of the national life. Whether unemployed people are termed a "hard core" or are considered as an insidious dry rot in

¹ It was estimated that in all Nyanza Province in 1935 £368,000, or only about Sh. 21 approximately per household, was available for 361,719 households averaging 3.23 persons each, for spending on clothing, extra food and manufactured products when tax charges (amounting to £224,000) had been met.

² This is taking an estimation of 28 per cent of the total population as being males between the ages of 15 and 60 and estimating the total native population as 3,500,000.

the fabric of society, their presence is a constant threat to the peace and prosperity of the society in which they are found.

However, unemployment cannot be solved by allowing or forcing the workless to crowd upon the land; nor can it be assumed, without disastrous consequences, that the land can absorb, with mutual benefit, those men whose characters and abilities promise little success elsewhere. Unfortunately, it has long been a tradition that agriculture is a suitable mode of life for the fool of the family. Africa is tending to adopt this European fallacy. But the land, in which society is rooted, demands the services of some of the best men which society can produce if it is not to fail to nurture that society. It has been seen that, under conditions favourable (perhaps exceptional in some areas), the prospects afforded to the African by agriculture in East Africa can compete very favourably with those offered by other careers. Despite this and undaunted by the low standard of life of the majority of East African natives in towns, the high rewards obtained by a relatively small proportion of urban natives and the glamour of city life attract a large number of educated or semi-educated natives to the towns who might otherwise lend their abilities to the improvement of agriculture.

There is another side to this matter, however, and one which enables more sympathy to be given to the African who seeks his fortune in the towns. The financial success of the African farmer, like that of his brothers tilling the soil throughout the world, depends in large part upon the vagaries of world prices for the primary products of agriculture. These sudden rises or declines in price, having no relation to the effort or expense of production, perplex the African to a greater degree than the more cynical European producer. But the African, even when prices are favourable on the world market, is too often handicapped by having to farm an area of land which, far from being an "economic unit," is barely sufficient to provide a subsistence.

Graham has described the excellent results obtained from farming six acres of fairly fertile land at Bukura, improved vastly by good husbandry over a number of years. Two cropping seasons a year may be utilized on this land also. Other areas are less fortunate in climate, soil, or both. The means of providing a smallholder, in a suitable area, with the considerable capital needed, even where implements are shared amongst neighbours, requires

thought. We are left with some other pertinent queries also. Will a return of Sh. 1,000 per year (though far above that of the average cultivator at present) suffice for the needs of the African of the future? If the answer is in the negative, what will be the minimum requirements and by what improvement in agricultural methods, by what system of land tenure, and on what area of land, on each soil type and in each climatic region, could such a minimum standard be obtained?

POPULATION PROBLEMS

The time has come in many parts of East Africa when the reduction of the infant mortality rate, *per se*, unaccompanied by measures to prevent the population increasing at an alarming rate, must be looked upon askance rather than as an unmixed blessing.

Tribal or racial migrations or wars of the past, like in part the nationalistic furies of the present era, had their origin in an urge for more *lebensraum* when the maltreated earth, over-cultivated or overstocked, refused to yield any longer its accustomed bounty. The soil of Africa, a continent notoriously of poor fertility when regarded as a whole, is swift to take retribution when abused by man and his cattle.

How can we reconcile a stationary or growing population in many parts of Kenya with the fact of a deteriorating physical environment? How can we regard as compatible a rapidly increasing demand for the amenities of civilized life with minutely subdivided agricultural land (often intrinsically poor), tilled by primitive methods and this by Africans bound and fettered by out-worn customs and rights under which the land steadily wears away? Grassless wastes, rock-strewn barren fields, and sand-filled riverbeds, bear witness to the result of men and stock multiplying beyond what the land can bear. The amount of land which is still available for the support of human life is shrinking further under ill-usage. The six acres per family of some of the Bukura experimental farm units are unobtainable in areas which are far less blest in soil and climate, certainly the potential productivity represented by the Bukura six acres is often unobtainable on the land of the average family.

The fact must be faced. Throughout history, human beings ceaselessly multiplying have reduced their numbers periodically by war, the conflagration of which has often been caused by the conflicting demands of expanding populations. Alternatively, numbers have been reduced perforce by famine; witness the 1893-99

Njaa Kubwa in Ukamba, when 50 per cent of the population are said to have perished in some parts and 75 per cent in others; or by disease, as when the Black Death devastated Europe in 1349, killing half the population of England; or when the influenza epidemic swept the world after the first Great War, causing, it is said, twenty million deaths or greater losses than the war itself. While famines usually are caused by climatic aberrations, their effects are often accentuated by previous dissipation of the fertility of the soil by bad methods of husbandry or by overcrowding. If too large a population attempts to live directly from the fruits of the land, any small deviation of the climate from the accepted normal may lead to famine.

War as a means of reducing population is not indicative of moral or spiritual progress. Through the mechanization of warfare, war no longer has the biological merit of bringing about the survival of the fittest—if it ever did. Birth-control for long has been the resource, in defence of their standards of life, of the more educated and intelligent sections of European nations. This knowledge of methods of contraception should be made accessible to the African, that his chances of a better life may not be smothered by being one of a crowd of struggling, poverty-stricken, ill-nourished fellow Africans. The land must only be asked to carry such an agricultural population as can live on a scale befitting a race which has risen above barbarism and annual dread of the hungry end of the dry season. To acquiesce in the cramming of any excess number of people upon the land is to exhibit passive enmity to Africa and the African, and to assist negatively in the dissolution of the country's future.

It would be idle to under-estimate the enormity and number of the obstacles hindering a constructive land policy. Obstacles must stimulate not deter us; *laissez faire* is the device on the banner of the defeatist. Absolutely essential is the provision of means of employment for the population surplus to those who may be permitted, by the exigencies of the land, to engage in agriculture. Within the village it should be possible to foster the growth of village industries, such as spinning, weaving, pottery, blacksmithing, mason-work, carpentry, tailoring, and other crafts which can be supported by the agriculturists living on adequate and fertile lands. The concept of colonial native peoples as existing economically to supply raw materials and to purchase manufactured pro-

ducts from Europe must be abandoned; the land demands it.

It may be objected that factory-made products from Europe or the East can be supplied to the consumer far cheaper than articles made locally by village industries. This may be so; but nineteenth century economics do not solve the social problems of to-day. The African communities must become more self-supporting and village industries must not be regarded as competing on world markets, except in special circumstances. Material benefits of the few must be regarded as secondary to the social and moral benefits of the many. Any monetary losses suffered by the cultivators must be regarded as the price he has to pay for undisturbed possession of an adequate area of land. The virtual subsidization of local industries must be regarded as far preferable to a dole system for landless and workless people, under which energy dies, initiative languishes, and hope disappears. Beyond the village, large-scale industry (possibly run on co-operative lines) may absorb other families and, by technical efficiency, contrive to compete successfully on the export market.

Until such time as the population settles down to the capacity of the land, business and industry to support the people, public undertakings of afforestation, roadmaking, soil and water conservation, and drainage must be put under way in order to take care of the surplus people. Above all, it must be stressed that it is no more possible in Africa for every family to own or occupy a self-sufficient holding than it is in Europe, and the situation arising when this principle is accepted, as accepted it must be, must be faced immediately. The provision of new settlement areas is a temporary and partial expedient which is extremely limited in its future application if the land is to be used and preserved permanently for the benefit of the people. Wise land-use does not mean using the maximum proportion of the land for agriculture. There is much land which is too steep, or too poor, or in which the climatic hazards are too great to permit of agricultural settlement. Forests must be retained to safeguard the water supplies, to supply timber for domestic and industrial needs, and to make the dry air more cool and moist.

CONCLUSION

This article has been written as a challenge and an appeal. First of all the material and cultural standards which are to be aimed at for the African must be clarified. It has been shown that the cost of a *minimum* nutritional

and living standard is far above what can be generally realized under existing conditions. What material or cultural advance should be attained beyond this minimum living standard is a matter for future determination.

The dangers of uncontrolled individualism in matters of land development and land tenure may be seen in the United States of America, a country in which agricultural and economic trends may be studied to great advantage.

As an alternative to regulated individual tenure, the possibilities in some areas of collective or co-operative farms or of communally utilized and controlled pasture should be examined.

The better use of the land and greater prosperity for the community hinges upon the suitability of the methods of land tenure which are current or are developing in East Africa. In the past the subject of land tenure has been handled most gingerly, mention of the problems it affords has been with almost bated breath. Institutions have been left "to develop naturally"—as though African customs have not already been sufficiently influenced (if impersonally) by the impingement of Western culture, as if "natural" evolution of social organizations has ever led to the protection of the weak or to the conservation of natural resources for the benefit of the nation! Did private greed or unchecked selfish instincts ever become canalized to the maximum public benefit? Much loss and suffering may result before individual benefit is made to yield to the cause of the general good.

This is not a suitable place to discuss the means to the end—the protection of the land and the maximum prosperity and happiness of the people; suffice it to indicate the urgency of the need for a broad approach and a determined one to this question; the danger of neglecting or avoiding its settlement.

In order to obtain a balance between agricultural workers and the land, to the mutual benefit of land and people, the needs of the people who are surplus to agricultural possibilities must be considered. The development of industries in the village and the factory must be undertaken from the social rather than from the coldly economic point of view, which may be a shortsighted one. A *laissez faire* attitude in this regard will not suffice. We must think in terms of human happiness, not of devil-take-the-hindmost finance; of the people and the land, not the people or the land as separate entities.

In order to avoid hardship caused by any regulations which may be necessary to safeguard the future of the land and the prosperity of the people of the Colony, plans must be made well ahead for industrial development designed to provide for those families which it is not desirable should continue to graze stock or cultivate the soil. Technical schools suggest themselves. Careful examination should be made of the possibilities of any industries for which the raw products of the Colony would lend themselves. Assistance must then be provided to start any such suitable industries, whether controlled by private co-operative or state interests, while ensuring that due regard shall always be paid to the interests of African workpeople in these industries.

Lastly it must never be forgotten that happiness and contentment will never be attained by African peoples unless the requirements of a disciplined and developed mind and spirit are considered with no less attention than their material needs for bodily health and comfort.

REFERENCE

- [1] "A Report on the Housing and Care of the Native Population resident in Native Townships and Locations in the Union of South Africa," J. Norman, 1940.

THE LETHARGY OF MALNUTRITION

It now remains to consider the actual food that is being consumed by primitive peoples like the African tribes, and how, with the reform in their farming processes they can be ensured a dietary which is not only adequate in amount but which satisfies what latterly we have learnt to be the requirements of the human body for the food accessories like vitamins and minerals. We must not assume that experience and instinct will always establish a practice which provides for these requirements. One can find examples which show how natives have been reaching out

empirically towards repairing deficiencies, as by the addition of certain leaves or mineral earths to the food, but in effectiveness they represent little more than the dog's habit of eating grass when it feels off colour. Individuals, indeed whole tribes, who have fallen below the normal in their dietary, affected also by the diseases which become widespread with under-nourishment, are apt to fall into a state of depressed acquiescence and lethargy until they do not even recognize their condition.

Sir A. Daniel Hall: *The Improvement of Native Agriculture in Relation to Population and Public Health*, p. 65, 1936.

VERMIN DESTRUCTION

By E. L. Bradford, Dip. Agric. (Cedara), Asst. Agricultural Officer,
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In several parts of East Africa, especially in the forest and heavy bush areas, the vermin scourge is a very serious one, resulting in serious loss of crops. So serious indeed are these losses that natives have been known to abandon cultivation in certain areas and seek pastures new. Indeed crop plantings are often of necessity determined and controlled by the incidence of vermin. For instance, in the Imenti Division of Meru, adjoining the Mt. Kenya forest-line, field peas were grown very extensively before baiting was instituted and English potatoes were grown in lieu of sweet potatoes, because peas were left untouched by bush pig and English potatoes were a short-period crop compared with the sweet. It is a common practice in many districts for the entire adult male population to sleep in their shambas at night when crops are maturing in order to reduce crop losses to a minimum. This reduces native efficiency during the day, an important economic factor which is often lost sight of. A farmer is an optimist if he expects to harvest his crops *in toto*, with pests and diseases abounding, but when to these are added the unwelcome attentions of baboons, pig, porcupine, squirrel and buck he is indeed overburdened with adversity, despite its many "sweet" uses.

A few suggestions, therefore, and methods recently found efficacious may prove of assistance to long-suffering farmers.

Arsenite of soda, strychnine, and sulphur candles are used. As the two former are highly toxic, indiscriminate application in the shamba is deprecated. Vermin should be baited at or near their lairs, which are usually, for obvious reasons, away from habitations. Such baiting, besides being safer, is more effective in that all paths radiate from their lairs and, on the particular days of baiting in shambas, the vermin may have decided to visit shambas in the opposite direction via Route B, and such bait is wasted. Thus baiting at the source is more liable to poison the whole family than baiting in shambas. Furthermore, it is recommended that poisoning be conducted at each lair for three days in succession in order to exterminate the whole family; for usually the adults do the marauding whilst the young remain at home.

Some species of vermin are more intelligent and wily than others, and hence require more

care and thoroughness in baiting. If one of the family succumbs to baited maize or potato the remainder may decline to take such bait, and it is necessary to change the diet. Alternative diets are therefore given hereunder.

Vermin are more accustomed to *bouquet d'Afrique* than to the scent of the European, so it is advisable for a native to prepare and handle the baits.

To enhance the success of baiting it is psychologically important to go one better than their current diet. For instance, if pig are raiding maize shambas, it is probably because there is no potato plot available, therefore bait them with potatoes, which is more of a true hog diet. If both maize and potatoes are available in the shambas, then goats' intestines would prove the *pièce de resistance*.

The following are the baits and methods of application used for vermin:—

Maize.—Green cobs in the sheath are preferable. The sheath is pulled back but not removed. A cut from tip to butt is made in the grains with a knife and the cut surface is opened slightly to allow of insertion of the poison, which is then applied, the cut grains squeezed together again, and the sheath returned to its original position covering the cob.

Another method advocated by the Game Department is to cut each green maize cob into pieces of a size pigs will take and swallow in one mouthful, with arsenite inserted in say three rows of kernels, for baboons and pig do not usually eat a whole cob but merely nibble out portions.

Maize grains, preferably in the dough stage, are used off the cob for smaller animals (e.g. squirrels), but prepared in the same way as above, and then removed from the cob.

Potatoes (Sweet and English).—A small circular hole about the circumference of a lead pencil is cut with a knife to the centre of the root; the bait is applied and the plug cut out by the knife is replaced, so that the root looks untampered with.

Pumpkins.—As above.

Wild Fig.—The fruit is cut, the poison inserted, and the cut closed together.

Bananas.—A round plug is cut out, as explained above, and replaced after inserting the poison.

Cassava.—As for potatoes.

Meat.—If the meat is from a kill, it is better not to move the carcass but bait it on the spot by making an incision in each limb, the head, and intestines, inserting the poison, and closing the cut edges.

For hyenas, bait along their paths starting from close to their holes and dropping baits at wide intervals. Use large pieces of meat, otherwise the first animal to emerge for the nocturnal hunt takes all the bait and the laggards escape unscathed.

Miscellaneous Baits.—When vermin are becoming too accustomed to routine baits and are tending to pass them by, a more tasty change of diet is indicated, or, alternatively, a diet which they do not suspect has been tampered with. The following examples are given:—

For Porcupine.—Roasted goat bones with some residual meat left thereon is a special delicacy. The arsenic is inserted in the meat in the usual manner.

For Warthog and Bush Pig.—Raw chicken meat, and roasted goat bones as explained above. Indigenous roots. The most attractive bait of all, however, is the intestines of goat, either fresh or somewhat "high".

For Baboons.—*Mituja* fruit (*Myrianthus arboreus*), which is somewhat like a mulberry in appearance, is a palatable diet for baboons and monkeys. Also chicken baited intact, not plucked, and incisions made in breasts, legs and head, and arsenic inserted, is a bait which baboons will take unsuspectingly. This would only be of economic use in areas where chickens are cheap and for baboons which have become too wary to touch other baits.

Poisons and Dosage

Great care is necessary in giving the correct dosage. If too much strychnine or arsenic is given the animal vomits and the action is nullified, whilst an insufficient quantity is a tonic (in very small amounts) or will merely temporarily incapacitate the animal—and make him wiser in future. Correct dosage cannot ever be guaranteed where wholesale poisoning is undertaken, as so much depends on the number of baits found and eaten by individual vermin. This can be partially remedied by spreading the baits widely (as in the case of hyena), but cannot be overcome when baiting in porcupine and wart hog holes.

The point of an ordinary-sized pocket-knife is the most convenient form of measure. Mark

with a file one-fifth of an inch from the tip for strychnine dosage and half an inch for arsenic.

With bush pig and wart-hog the bitterness of strychnine is occasionally found to act as a deterrent, and a mixture of strychnine (one-fifth inch) and arsenic (half inch) is taken more readily, the actual dosage of the mixture being as for pure arsenic.

Lay the bait at about 4 p.m., so that it is fresh and attractive when the animals emerge. Note the number of baits laid. In the morning return to check the bait remaining, remove and burn or bury. Re-apply fresh bait in the late afternoon. It must be remembered that old bait is far from attractive, and if left, and fresh bait added, will tend to put the animals off the good bait. Furthermore, with strychnine-baited meat left over from previous baitings it would appear from observations made that the acid in the meat causes a reaction on the strychnine, reducing its toxicity. After baiting look for carcasses; this is the best criterion as to whether or not the correct dosage is being applied. Wet weather baiting does not appear to produce such good results.

Sulphur candles are supplied in four sizes. Size No. 3 is sufficient for a medium-sized hole of porcupine or wart-hog. A larger hole would require two No. 3 candles. As porcupine nests have several exits, if the nest is a large one it is advisable to select a well-used hole on either side of the nest and apply a candle in both. The best method of application is to completely close with earth the holes not to be treated. A gunny bag is pegged over the hole or holes to be fumigated, leaving one corner loose. A small smouldering fire is placed well in the hole (a full arm's length, so that the bag does not catch alight). Loose earth is dug ready outside the entrance. The candle is then placed in the smouldering fire, the remaining corner of the bag pegged down, and the loose earth packed around the edges of the bag to keep the fumes in. It may be necessary to stand by with a spear or *rungu* for a few minutes in case the animals try to force their way out, but this seldom happens. Wart-hog holes are similarly treated.

The Most Appropriate Baits and Poisons for each Class of Vermin

Porcupine.—Poison: Arsenite of soda or sulphur candles. Bait: Maize cobs, green maize cobs cut into three or four pieces, potatoes, bananas, cassava. (See also under "Miscellaneous Baits.")

Apply at the entrance to the holes. After three applications smooth over the soil round the entrance and if spoor is subsequently observed continue baiting. In a week's time, if a stench and flies emanate from the hole there will be no doubt that the correct dosage has been found.

At certain times of the year, usually the hot months around harvest time, the porcupine desert their holes and lie up in the bush. Baiting during such periods is useless.

The most effective method with arsenite bait is that recommended in the article "Vermin on Farms" (this Journal, Nov., 1939), namely by closing all but the main hole by forcing thorn branches in as far as possible with the aid of a long forked pole, or otherwise blocked from floor to ceiling with logs of wood, stones, etc. The entrances are themselves then covered with logs, stones, brushwood, etc., and completely buried under three feet or more of earth.

Poisoned foodstuffs are then conveyed as far as possible down the one main hole by the smallest totto available. Three or four baits should be calculated for each porcupine occupant suspected. This main hole is then closed as thoroughly and in similar manner to the others. Before the porcupines can burrow out hunger compels them to eat the baits, and it results in a complete wipe out.

Bush Pig (Nguruwe).—Poison: Strychnine or a mixture of strychnine and arsenite of soda. Bait: Maize cobs, green maize cobs cut into three or four pieces, potatoes, bananas, cassava, pumpkin. (See also under "Miscellaneous Baits".)

A most difficult fellow to eliminate entirely. He is so cute that, if his tracks are used by the baiter, he will abandon them for three weeks or more. Having no hole, but lying up in fairly dense bush away from habitation, one has to bait his tracks as near his lair as possible. Such tracks have therefore to be approached at right angles, and never walked upon; the baiter returning by the way he came.

It is often found that the pig track crosses a native path deep in the bush. Without following along the pig track throw the bait in as far as possible and stick the spot alongside the native track in such a manner as to acquaint passers-by of the *tabu* (each tribe has its own methods and signs).

Vary the diet daily, and when the pig are becoming scarcer after a period of baiting, and more wily, proceed with the miscellaneous baits.

It will be found as baiting proceeds that they have become too wise to touch any bait. It is necessary before this occurs to cease baiting for three to six months, and then try again.

Wart-Hog (Ngiri).—Poison: Strychnine or mixture of strychnine and arsenite of soda, or sulphur candles. Preferably the latter, as pig can be eradicated at once before they become too sophisticated. Baits: Maize cobs, potatoes, bananas, cassava, pumpkins. (See also under "Miscellaneous Baits".) Bait at entrance to their holes, first checking up on the spoor to make sure the pigs are at home. If uncertain, smooth over the soil at the entrance and return later. A dog will often reconnoitre and indicate for one.

Hyena.—Poison: Strychnine or sulphur candles. Baits: Large pieces of meat, each baited once. Lay the first bait near the entrance of the hole, then the others at well-spaced intervals along their paths. Two to three sulphur candles are recommended against hyena when fumigating.

Baboons and Monkeys.—Poison: Arsenite of soda or a mixture of strychnine and arsenic. Baits: Maize cobs, green maize cobs cut into three or four pieces, potatoes, pumpkins, bananas, wild fig. (See also under "Miscellaneous Baits".)

These animals have favourite hang-outs here and there along the river banks, probably a particularly large dense tree. From there they will probably move either during the day or the following day to another of their favourite spots (very often further down the same river). These haunts must be noted, or native knowledge obtained concerning their haunts, and when the baboons are known to be on that particular river all the favourite places should be baited, so that, should they move off on the approach of the baiter they will find the "table laid" at the next spot. Lay the bait at the foot of each favourite tree and lay enough to go round.

Another method recommended by the Tanganyika Game Department, and modified by the Kenya Department, is as follows:—

Take three-quarters of a petrol tin of mealies; make a solution of three-quarters of a cigarette tin of arsenite of soda, pour into the mealies and stir thoroughly until well mixed. Boil thoroughly in plenty of water until the skins split and the mealies can easily be mashed between the fingers and thumb. Cover the tin and put away till cold. Then take 5 lb. cheap sugar in solution and sweeten the mealies to

counteract the bitter flavour of arsenic. The bait is then laid in the shade near where the monkeys sleep.

This is a more expensive method and the technique is less easily followed by native baiters. It is supposed to be more effective, but as the writer has a bag of thirty baboons in two days to his credit with the first method outlined above, one takes one's choice.

Squirrels.—Poison: Arsenite of soda (one-third normal quantity). Bait: Maize grains or small cubes of potatoes. Squirrels' depredations are usually not very far from their holes, usually at the base of a tree, or a hole in a tree, or a hole among the roots of dense scrub. When observed in the shamba and chased they can usually be traced to their homes. Bait at the entrance, or, if in a tree, lay the bait at the foot. If a sulphur fumigating pump is available, squirrel, wild pig and porcupine could be treated therewith.

Wild Cats, Civets, Servals, etc.—Poison: Strychnine (one-quarter normal quantity). Bait: A whole chicken with feathers intact.

The minutest quantity of strychnine is required as all felines can so readily vomit. A single crystal of strychnine is sufficient. To check on the dosage, tie the chicken carcass to a peg so that it cannot be carried off. If pro-

perly dosed the carcass of the cat should be discovered nearby in the morning.

Buck.—Poison: Arsenite of soda. Bait: A load of earth from the nearest local salt-lick. Lay the lick where the tracks of the animals are found to enter the shamba. When the game has located the lick sprinkle the arsenic thereon and mix slightly. As stock are apt to fall to this bait they must be grazed elsewhere for a couple of days or so, until the remaining lick and poison has been well scraped up and buried.

In conclusion, I would strongly emphasize certain points which must never be lost sight of.

Firstly, before baiting warn all people concerned, your own staff and your neighbours.

Secondly, arsenite of soda, being a mineral, is indestructible. Even after burning the ash is toxic, and unused baits must therefore be deeply buried. Strychnine, being of vegetable origin, is destroyed by fire. It is of the utmost importance that residual baits and utensils used should be properly disposed of after use.

Thirdly, careful handling of poisons.

Fourthly, wash the hands thoroughly, and under the nails, when the job is finished.

Lastly, be thorough in baiting operations, for slack and careless methods very frequently account for poor results.

(Received for publication on 3rd March, 1941.)

REVIEW

A CHECK-LIST OF THE FOREST TREES AND SHRUBS OF TANGANYIKA, PART I.

The latest of the Check-lists of the Forest Trees and Shrubs of the British Empire is No. 5, Tanganyika Territory, Part I, edited by the late Dr. Burt Davy and compiled by Dr. Hora in collaboration with Mr. Greenway, of Amani, and the Forest and Tsetse Research Departments of Tanganyika. It is published by the Imperial Forestry Institute, Oxford (price not quoted). The previous lists in this series were those for Uganda, Nyasaland, Gold Coast, and Ceylon.

This list is an excellent example of effective co-operation between scientific departments in East Africa and Great Britain and gives the lie to the accusation of lack of co-operation sometimes heard in connexion with biological research within the Empire.

This volume, which runs to over 300 pages, contains firstly, an alphabetical list of families and their included genera (List A) and secondly, a botanical-vernacular index (List B).

In List A the taxonomic position of the genera is indicated, while in List B the genera are arranged alphabetically with citation to the family to which each belongs. This arrangement facilitates ready reference, and is an improvement on the format adopted in the four earlier lists.

Our only criticisms of this excellent compilation are, firstly that certain name changes do not appear to have been effectively published, and, secondly, that certain herbs and twining plants are included which cannot truly be called trees or shrubs.

This check-list ought to be accessible to every forestry and agricultural officer in East Africa, and should find a place beside Greenway's Swahili-Botanical-English Dictionary of Plant Names, and Burt's Field Key to the Savanna Genera and Species. We look forward to Part II, which will contain an annotated check-list with descriptive and ecological field notes.

A.G.H.

COMBATING SOIL EROSION IN THE CENTRAL PROVINCE OF TANGANYIKA TERRITORY

PART I

By R. R. Staples, M.A., Dip. Agric. (Cantab.), attached Department of Agriculture, Tanganyika

INTRODUCTION

Accelerated erosion, in its most advanced forms, menaces the welfare of the African peoples inhabiting the Central Province of Tanganyika Territory. This problem is bound to arise where some half a million natives, one and a quarter million cattle and a million sheep and goats are all engaged in an often desperate struggle for existence (largely due to the primitive methods of land use) in a semi-arid country. The need for soil conservation in this Province is so pressing that it has been laid down that anti-erosion work shall form the basis of increased production work even during wartime. The task of staying the evil is an enormous one and an account of the efforts being made may be of general interest. Before dealing with the problem in detail, a short description of the natural features of the region is necessary.

GENERAL DESCRIPTION OF REGION

Physiography

The Central Province of Tanganyika is a part of the great central plateau of eastern Central Africa. It is a series of vast peneplains, apparently unlifted in the past and possibly still rising through tectonic movement, with a definite tendency to tilt backwards. The eastern boundaries of these plateaux, therefore, are steep escarpments and the loss of elevation with distance from the scarp edge is of particular importance in the understanding of the climate. This interesting and unusual formation has also resulted in an almost entire absence of drainage into the sea and the formation of frequent seasonal swamps (the Wembere in the Singida district and the Bahi swamps in the Dodoma district occupy many hundreds of square miles during the rains) or more permanent lake pans, as at Singida, into which sandy rivers discharge their muddy waters in the rainy season. Remnant hills and more occasional high blocks (such as the Kiboriani block at Mpwapwa) relieve the monotony of these great plains; they are also of great importance as sources of the majority of the few permanent streams in the Province.

Geology and Soils

The main rock formations of the Province are acid granites and gneisses of very great age, overlain in parts by much younger superficial deposits. Basic rocks (dolerites, serpentines and greenstones) do occur locally, but do not affect the soils to any great extent. The line between the granite and gneiss formations runs approximately from north to south to the west of Kondoa Irangi and about half way between Dodoma and Mpwapwa. Overlying much of the granite in the west is an important superficial deposit of pre-Rift age known to Tanganyika geologists as "the Grey Cement," which in some areas give rise to soils of extreme acidity.¹ The geology of this tropical area is of particular importance in its farming potentialities, as owing to the dry climate and high temperature, the soils appear to retain the characteristics of the parent rock to a far greater degree than is usual under more temperate conditions. This applies particularly to the sedentary soil types.

The soils of this region are, as may be expected, very variable, the three main types being: red sandy loams; grey sandy soils; and dark coloured heavy clays. Frequently these are in catenary formation, the red loam on the upper foot-slopes, the grey sands on the lower foot-slopes and the heavy clay in the flat and seasonally waterlogged bottom-lands. These soils together with their sub-soils are usually of good depth. Milne [1] discussing one of the types says: "From the agricultural viewpoint a notable feature of the red sandy soils is their continued productivity on severely sheet-eroded surfaces, admittedly at a low level of yield but still far short of infertility." He also goes on to express the opinion that "the soil type in question is an exceptionally favourable one for yielding an immediate return for effort expended on measures of conservation". From my experience both the red loams and the grey sands, once they have lost their "virgin" fertility, behave in this manner and simplify reclamation particularly from the pasture viewpoint. The soils generally do not appear to have suffered greatly from leaching and they also do not show laterization to any degree.

Climate and Rainfall

The available records from thirteen stations in the Province give annual rainfall averages varying between 20 and 30 inches. Although not very distinctly, the rainy season may be divided into three periods. Phillips [2] gives these as: "(i) an early or 'short' rainy season October–November to late December or early January; during this period the vegetation flushes into foliage and many species flower; grasses develop vigorously; natives cultivate. (ii) Late December or early January to mid or late February: a decidedly dry period, broken by several torrential thunderstorms; the catch during these storms obscures the fact that the period is a dry one. The grass may or may not dry the colour of straw in all but the cooler and moister sites; the trees and shrubs in warmer, drier localities may show flaccid foliage. (iii) Late February to mid-March to April–May: the season of more regular distribution of rainfall. April–May to October–November is the true dry season, during which no rain falls, or at most a few millimeters." The main feature of the rainfall, however, is its uncertainty; a large part also falls in torrential downpours of as much as three inches in the course of an hour. During the frequent drought periods, temperatures are high and scorching winds are experienced. Without exaggerating, therefore, the climatic status of the Central Province may be said to be low and it thus seems better suited to pastoral than to arable agriculture.

Vegetation

From the pastoral viewpoint the three main vegetation types in the Province are: (i) Deciduous Thicket or Scrub (*mchaka*); (ii) *Brachystegia-Isomerlinia* grassy woodlands (*myombo*) and (iii) flood-plain grassland (*mbuga*). Through man's activities numerous seral (developing) stages of the first two types are to be found, the most extreme form of which is the open "cultivation steppe".¹

Thicket or scrub are the dominant types in all the drier and warmer parts of the region and throughout on heavier soils that are not seasonally waterlogged. Fully developed types of this vegetation cannot be fired or easily grazed, as they are almost impenetrable owing to their density or thorny nature. They are composed chiefly of shrubs and small trees with a few larger trees up to 50 ft. in height and frequently with an occasional massive baobab towering above the thicket growth.

In the more open secondary thicket stages of this type, annual grasses and weeds form an important part of the plant community and they afford the bulk of the feed for stock, although the leaves of most and the fruits of some of the woody species are also highly palatable. Where the woody vegetation is mostly suppressed by man's activities (and the goat), annual grasses and weeds are normally the most important species, with valuable perennial grasses (*Cynodon*, *Eragrostis*, *Cenchrus*, *Bothriochloa* and *Heteropogon*) as associated species and locally dominant on favourable sites.

Grassy Woodlands.—This is the most important vegetation type of the somewhat cooler, higher lying and more favourable rainfall plateaux and mountain slopes of the Province. The dominant trees (*Brachystegia* and *Isomerlinia* spp.) are deciduous and are leafless during a part of the dry season. Their espacement and size varies greatly as does the density and growth of the grass "floor". The latter is composed mostly of perennial grasses (species of *Hyparrhenia*, *Digitaria* and *Setaria*). The soils under this type are generally light in texture and of indifferent fertility and both stock owner and cultivator view these lands with less favour than the areas where the thorny thicket types flourish.

The flood-plain grasslands are normally too wet for cultivation (except for rice and to a lesser degree for sorghum millet) although the water-logging is usually confined to short spells of wet weather. The large variety of perennial grasses which flourish in these soils are highly nutritious and afford valuable pasturage for stock, and this at present is their main contribution to the economy of the Province.

Population

The area of the Central Province is 37,497 square miles, divided administratively into three districts: Singida (with Mkalama as a sub-district); Dodoma (with Mpwapwa and Manyoni as sub-districts); and Kondoa Irangi. In this large stretch of semi-arid country, the 1931 census gives a total population of 579,712 people or 12.9 per cent of the entire population of the Territory and contributing about the same percentage of the total tax collection. These figures give a concentration of only 15.5 people to the square mile, but by far the greater part of the Province is waterless during the dry season or infested with tsetse flies and for these reasons uninhabited. Actually certain

¹ "Steppe" is perhaps hardly the correct word, but for want of a better term "cultivation steppe" is frequently used in East Africa to describe open, densely populated areas with scattered trees, often giant baobabs, and closely grazed and usually scanty grass-weed herbage between the numerous cultivated fields.

portions, particularly the "cultivation steppe" islands, are fairly densely populated with as many as 150 persons to the square mile. A good portion of the population, however, lives in small settlements with meagre water supplies and in a sea of bush.

There are four main tribes: the Gogo in the Dodoma district; the Nyaturu in the Singida district; the Iramba in the Mkalama sub-district of Singida; and the Irangi in the Kondoa district. The Gogo and Nyaturu are large owners of cattle, in which their chief interests lie, and are very indifferent agriculturists, particularly the former. The remaining two tribes are also fairly large stock owners but are moderately industrious cultivators.

Stock and Crops

Native owned stock in the Province number some one and a quarter million cattle and about a million sheep and goats. If these were distributed evenly amongst the population, which they are not, this would give about seven head of cattle and five sheep or goats per taxpayer, a not unreasonable number for a predominantly pastoral country.

Stock are at present the chief source of income to the people. The sale of beasts for slaughter varies considerably from year to year, depending on the income derived from other sources, but appears gradually to be increasing as the economic needs of the people grow and they become more accustomed to selling their stock. In 1940 for instance, no less than 53,000 cattle were sold on the markets of the Province, largely to Liebig's meat factory in Kenya. Hides and skins, usually shockingly badly prepared, ghee and clarified butter also contribute appreciable amounts to the annual income. With the present methods of pasture management and through concentration brought about by tsetse encroachment and limited water supplies, many of the stock-carrying areas are overstocked, although the number per head of population is, as already stated, hardly sufficient for the needs of the people.

Normally the food requirements of the people are grown by themselves, but local shortage is frequently experienced. The staple crop is the drought-resistant bulrush millet, which in storage is also very resistant to insect attack and hence can be kept for several years. Maize and sorghum (the latter chiefly for brewing beer) and a variety of pulse crops are also grown. Cassava and sweet potatoes are not popular, largely owing to the protection they require from stock and game during the dry

season. Groundnuts and surplus grain are the chief cash crops. Yields of groundnuts vary considerably from year to year, market sales in the record season of 1937 reaching some 5,000 tons; in an average year, however, only about half this quantity is produced.

With the combination of generally poor soils, unfavourable rainfall distribution and low standard of cultivation, crop yields are low, perhaps the lowest in the Territory. For this reason the average acreage cultivated per family is unusually large (about eight acres). There seems no reason, however, why ample food supplies for the people cannot be produced locally from a reasonable acreage, if more attention is paid to manuring, a wider range of crops and better cultivation; and an appreciable surplus of groundnuts, millets or maize and pulse crops for sale in good seasons.

PRESENT POSITION IN REGARD TO SOIL EROSION

Obst in 1911 described Kondoa as an oasis. At present it is doubtful whether more rapid accelerated erosion can be found in any part of the African continent. The necessity in this district to reduce the native poll tax from Sh. 10 to Sh. 8 was in my opinion mainly brought about by the ravages of soil erosion and overgrazing. The reasons for this undoubted increase in accelerated erosion of recent years seem to be: (i) *Pax Britannica*, enabling herds to increase and remain more or less permanently in one area, and (ii) increased acreage under cultivation through the combined stimulus of administrative persuasion and economic needs.

Gully and sheet erosion are both rife. The former is particularly severe in Irangi in both red and grey soils; the grey sands of the Iramba plateau of the Singida district and the red fan-slope soils of Ugogo are also seriously affected. Water-borne sheet erosion is general in practically all parts that are utilized for both cultivation and grazing; the only areas free from this evil are the almost level flood-plain grasslands. Accelerated wind erosion is less serious than the previous two types; the sandier soils of the Singida district, with its high winds, have been most affected, although all "cultivation steppe" areas suffer to some extent during the latter end of the dry season.

Whether the keeping of stock or the cultivation of the land is the more to blame for this high rate of accelerated erosion has frequently been the subject of argument. There is no

doubt, however, that these are the two factors responsible for the greater part of the trouble. In the Mpwapwa run-off and erosion plots, soil losses from a completely denuded plot (a condition approximating to that of much of the grazing land in the Province) and a plot planted to native food crops with native methods of cultivation, both tended to average about 50 tons of soil per acre per annum [3]. On the other hand, plots having a good grass cover lost only negligible quantities of soil. Termite activities are also an important contributing factor. Grass burning only plays a part in ungrazed or lightly grazed grassy woodlands and even in these areas does not appear to cause any great increase in the soil erosion rate. In the Mpwapwa run-off and erosion plots for instance, a burnt grass plot gave a run-off of 11.6 per cent of the rainfall with the loss of less than 0.05 tons of soil per acre [3]. Burning of annual grass pasturage may be expected to give a greater increase in the erosion rate, but firing of this type is not customary with Central Province tribes.

DEVELOPMENT AND PROGRESS OF SOIL CONSERVATION IN THE CENTRAL PROVINCE

Perhaps chief amongst those who first drew attention to the seriousness of soil erosion in the Central Province were Dr. Teale (now Sir Edmund Teale), for many years Director of the Geological Survey Department of the Territory, and Mr. C. Gillman, C.B.E., formerly Chief Engineer of the Tanganyika Railways and latterly Water Consultant. Largely through their efforts an unofficial conference of administrative and technical officers was held in Dodoma in 1929. As the result of this meeting strong recommendations were made to Government pointing out the seriousness of the position and recommending the enforcement of numerous ameliorative measures. Then followed the appointment of a standing Soil Erosion Committee for the Territory to advise Government on these matters. Since then a great deal of attention has been focussed throughout the Colonial Empire and indeed throughout the world on the erosion problem.

In 1931, investigational work was started at the headquarters of the Department of Veterinary Science and Animal Husbandry at Mpwapwa, on pasture management and other phases of the erosion problem. During the projects that have been started, and with what obtained for Central Province conditions and methods were evolved which satisfactorily

solved the problem on the Veterinary Reserve and farm at Mpwapwa [4]. These methods will presently be described in more detail. During this period, too, small Demonstration Stock Farms were started at Dodoma, Kondoa and Singida, where simple erosion-control measures were tried out and proved effective [5]. Otherwise, it is regrettable to record, little headway was made in combating the erosion menace, which daily was becoming more difficult to control in the densely populated areas.

In 1938, an Agricultural Officer (Mr. A. H. Savile) was posted to the Province (for a period of seven years no Agricultural Officer was stationed in the Province). He was charged to pay special attention to soil conservation matters. He remained in the Province until the outbreak of the war, since when the writer has been seconded from Mpwapwa to take charge of this work. Just previously Mr. G. J. Partidge assumed control as Provincial Commissioner and quickly became interested in the erosion problem and convinced of the importance of soil conservation work. Mr. A. Hartnoll and Mr. R. A. J. Maguire, his successors, have taken a similar keen interest in assisting to improve matters. The Province has also been fortunate in having in charge of the Singida district, for some years now, an Administrative Officer (Mr. A. W. Wyatt) particularly interested in anti-erosion work.

I can now pass on to a brief account, district by district, of the various soil conservation projects that have been started, and with what results.

MPWAPWA SUB-DISTRICT

Mention has already been made of the investigational work in connexion with soil conservation carried out at Veterinary headquarters at Mpwapwa and the success achieved in controlling erosion on the Veterinary Reserve and Stock Farm there. The methods used in pasture land were a combination of rotational grazing, bush clearing, grass planting and contour banking; and contour banking combined with ridge cultivation in ploughed land. Full descriptions of these methods are given in the Annual Reports of the Dept. of Vet. Sci. and An. Husb. Tanganyika Territory 1933-1938.

In addition the following district schemes have been undertaken:—

Deferred Grazing

As elsewhere in the Province permanent water supplies for stock in this sub-district are

badly distributed, resulting in much overgrazing with consequent erosion in the vicinity of the few supplies. In northern Mpwapwa there are extensive flood-plain grasslands which, owing to their lack of permanent waters, were made little use of by Gogo stock even during the rains.

Bwaga.—With funds (£100) provided by the Native Administration in 1938, shallow dams were dug (under the supervision of the Pasture Assistant of the Veterinary Department) in one of these plains due north of the heavily eroded and densely populated area around the Bwaga stream, which has its source in the Kiboriani mountain block.

In January, when the rain ponds and dams that had been dug had filled with water, all stock from within about eight miles from this stream were moved out (under the supervision of a Veterinary Guard) into the plain. The cattle fattened well on the good pasturage and returned to their home grazings in June, when the dam waters dried up, in excellent condition. The small stock, and particularly the goats, did not fare so well as they suffered badly from foot-rot due to the muddy condition of the temporary bomas during wet spells. For this reason and owing to the beneficial effect goat browsing was having in controlling bush regeneration in an experiment at Mpwapwa, it was decided to allow the small stock to remain at home in following years, a concession which did much to popularize the scheme.

Since then the scheme has run remarkably smoothly, with benefit not only to the home pastures and the land but in maintaining the condition of the stock and improving their productiveness.

Kongwa.—When the neighbouring chief of Kongwa saw the benefits of the Bwaga seasonal grazing system, he requested that a similar scheme should be started in his chiefdom where favourable conditions in regard to unused plains pastures also existed. Accordingly the necessary dams were dug with a further grant of £100 from Native Authority funds and under the supervision of the Pasture Assistant stationed at Mpwapwa. Here too the grazing system has run smoothly. It has taken only part of the time of one trained African guard to supervise both grazing schemes; they have benefited over 15,000 head of stock and allowed some 40,000 acres of land to recover partly or completely from the effects of overgrazing.

Mpwapwa.—A similar scheme was started (and supervised by the Veterinary Department) at Mpwapwa itself, where badly eroded land within four miles of the farmstead has been rested from grazing for a portion of the growing season in the last two years. I recently had the opportunity of inspecting this area and was much impressed with the improvement that has taken place.

Berege and Chunya.—Similar schemes were started in these two chiefdoms (flood-plain dams were dug in the Berege area) and reservation of the eroded home pastures carried out in 1939. Unfortunately, with changes and reduction of staff and less progressive chiefs, both these schemes have since lapsed.

Ridge Cultivation

Since 1935 a number of settlers (some sixty in number) have been allowed to cultivate and live on the Veterinary Reserve at Mpwapwa, providing they complied with soil conservation rules laid down by the Department. At the commencement of the scheme they were told to make large ridges (*matuta*) more or less on the contour and laid out by eye, at ten pace intervals in all their cultivated land. This measure, while found to be useful, especially in newly opened up land, did not prevent all soil wash.

In 1937, therefore, the settlers were obliged to cultivate the whole of their fields in contour (*matuta*) laid out by eye, except the land cleared for the first year as this is full of tree roots and also has little tendency to erode. This method of cultivation was found to be far more effective, although erosion still occurred with heavy storms. The ridge cultivation was fairly well carried out as the settlers were closely supervised; also a number of them were Wanyamwezi or Wahehe and accustomed to this method of cultivation.

In 1938, collaborating with the District Administration and the local Chief, ridge cultivation was enforced on a block of land of about a thousand acres to the east of Mpwapwa village and with a mixed Gogo and Wanyamwezi population. Here again the measure was useful in conserving soil except perhaps in unusually heavy storms, when much damage was done to the ridges. Difficulty was also experienced in getting the cultivators, and more especially the Gogo cultivators, to make the ridges reasonably on the contour and to protect their fields on slopes from run-off from the land above. The scheme has now lapsed.

In 1939, Native Authority anti-erosion rules were passed requiring crops other than millets to be planted on ridges, but little attempt was made to enforce these rules. In 1940, these rules were amended to require each man to cultivate a part (unspecified) of his land by this method. With the energetic efforts of the Assistant District Officer (Mr. D. S. O'Callaghan) stationed at Mpwapwa at the time, this rule was in a large measure enforced, particularly in southern Mpwapwa where there is considerable Hehe influence. In 1941, unfortunately with no Administrative Officer stationed at Mpwapwa the rule has more or less lapsed again although a good deal of ridge cultivation can still be seen in the vicinity of Mpwapwa.

Contour Banking, Bush Clearing, Grass Planting and Controlled Grazing

A demonstration combining all three of these anti-erosion measures was carried out on a very badly eroded, bare piece of about fifty acres of tribal land to the west of Mpwapwa. The Native Authority provided the funds and the Veterinary Department the supervision (Mr. H. Winship). The work was started in March, 1939, and by March, 1941, the reclamation of the area was almost complete: over much of it the eroded bare ground had been transferred into a luxuriant Star-grass pasture.

DODOMA

In this district anti-erosion work has been concentrated mainly on two large reclamation schemes and in encouraging deferred grazing. Some attention also has been given to the more general introduction of ridge cultivation and to demonstration contour-banked areas.

Msamalo-Igandu Reclamation Scheme

The main object of this scheme was to protect some ten miles of the main central Tanganyika railway track from the effects of flooding caused by the increased run-off through native use of the catchment area above the railway. At the time the railway was built, this area was unoccupied and bush-covered, the line as then constructed being built to a standard providing ample passage for flood water. Since then and principally in the last twenty years, natives (Wagogo) have come into the region and extensive areas have been cultivated according to their customary method. The land has also been heavily and continuously stocked. The occupation and use of

the land has involved the Railway Administration in considerable expenditure in repairing washaways in this area which yearly were tending to become more serious; increasing numbers of natives were coming into a similar area to the east as far as Igandu Station and new washaways were threatened.

In 1939, a meeting was held between the Provincial Commissioner (Mr. G. J. Partridge), the District Engineer, Tanganyika Railways, Dodoma (Mr. N. R. Rice) and the Agricultural Officer, Central Province (Mr. A. H. Savile) and a reclamation scheme was drawn up which it was hoped would prevent further washaways to the railway and at the same time reclaim the land which was rapidly being ruined. The scheme is important, as if successful it may revolutionize railway policy in regard to the maintenance of permanent way where it is being affected in this manner. The original details of the scheme as laid down are as follows:—

(a) The catchments concerned (between Km. 402 and 419), covering an area of some 10,000 acres, to be demarcated by means of stone beacons about 100 yards apart.

(b) Part of the worst-eroded area to be contour-banked (level interrupted banks, 4 ft. wide at base) and the gullies stopped with check-dams. Funds (£300) for this work would be provided by the Railway Administration.

(c) All fields to be cultivated on the ridge system (the ridges to be on the contour) before the commencement of the rains.

(d) The demarcated area to be closed to grazing until further notice; it was considered that it would be no hardship for the natives to graze their stock on the down-stream side of the railway.

(e) All further immigration into the demarcated area to be prohibited.

(f) Certain areas to be marked out and planted up as fuel reserves and in time no further cutting of firewood to be permitted on hill-slopes.

Progress Made.—The work on the construction of the contour-banks and the gully stops was started on the 1st August, 1939, under the supervision of the Agricultural Officer (Mr. A. H. Savile) and a District Foreman, assisted by a number of African Agricultural Instructors. A gang of 400 labourers was employed and each man was given a daily task of 30 yards banking three to four feet wide at the base about nine inches to a foot high. The soils were typical Ugogo "red-earth" sandy loams.

When I took over the supervision after the outbreak of the war, some 900 acres had been partly completed, at an expenditure in labour of some £200. I was convinced that the gully-stops would not be satisfactory under the conditions, so discontinued work on them and concentrated with the remaining funds on increasing the size of the banks to a width of at least 6 ft. at the base and proportionately high.

Even so, with the onset of the rains, heavy storms were experienced and a good deal of damage was done to the banks, particularly where they crossed gullies, and most of the gully-stops were washed away. Run-off from most of the area was exceedingly high, probably as much as 75 per cent in a heavy storm, as the soil for the most part was completely bare. The Railway Administration provided a further £50 for repairing the banks and for grass and sisal planting which I thought essential for the success of the scheme.

The cultivation of land into ridges in the dry season was particularly unpopular to the inhabitants of the area. While the sandier soils could be cultivated with reasonable ease with a good hoe, the average Gogo hoe frequently broke under the strain. Much of the land was too hard to cultivate at all. However, with the assistance of the Chief and considerable pressure, the cultivators managed to complete about half their fields before the rains started. The work naturally varied greatly in quality. Heavy storms caused damage to the ridges made. Delayed weeding (owing to the people still being busy in trying to complete ridging their fields) reduced yields. In spite of this, however, the crops compared very favourably with those planted on the flat outside the reclamation area, but the acreage planted per family was definitely less.

From the experience gained in the first year, it was decided to modify the cultivation rules for the present season. Ridging in the dry season was abandoned and cultivators were permitted to "dry" plant as is their custom; then at the time of the first weeding, they were required to tie-ridge. To assist them in making the ridges on the contour, instructors using striding levels demarcated contour lines every twenty yards in each field. Laying a portion of the uneaten crop residues along these lines and not burning them was found to be a satisfactory method of marking the contours. The families who have remained

have been better satisfied with these rules and far less difficulty has been experienced in enforcing them.

The enforcement of the grazing rules was easy after one or two offenders had each been fined a beast. The resting of the pastures, which started in November, 1939, was continued until July, 1940, when the stock were allowed to return. During this period the soil cover, composed of annual grasses and weeds, improved remarkably. Many complaints, however, were raised against the seasonal evacuation of the whole of the stock, so to make the scheme more attractive to the people it was decided to allow each family to retain four milking cows and all their small stock. The goats will assist also in keeping down the regeneration of the bush, which is fast becoming a problem.

No railway washaways were experienced in either the 1939-40 or 1940-41 rainy seasons, so from this point of view the scheme so far seems entirely successful. Run-off and soil losses have also obviously been reduced greatly, while the carrying capacity of the pastures is much increased. It must be recorded, however, that the enforcement of the cultivation and grazing rules resulted in about two-thirds of the population leaving after the first season. Those now remaining seem more content. Some difficulty was experienced with grass fires started by railway engines, and with the reduced population regeneration of bush, as already mentioned, is becoming a problem. With further funds (£50) provided by the Railway Administration, the silt which accumulated in the furrows on the topside of the contour banks was cleaned out; further sisal and grass was planted on the banks and secondary bush cleared or poisoned with power paraffin.¹ This latter seems to be a cheap and effective means of killing thorn trees.

Dodoma Reclamation Area.—With very limited staff it seems right to concentrate soil conservation work in a limited area first, which will then serve as a demonstration centre and a training ground for further staff. The severely eroded land in the immediate vicinity of Dodoma township, owing to the concentration of population and stock, also makes reclamation measures particularly urgent. For these reasons a meeting of the local representatives of the departments concerned (Administrative, Veterinary and Agriculture) was held in

¹ *East African Agricultural Journal*, Vol. VI (2), p. 91.

September, 1939, and a commencement was made with the following scheme on the land within a radius of three miles of the centre of the township:—

(a) The division of the area into grazing blocks (by earth beacons a hundred yards apart and planted with *Euphorbia* plants to make them permanent) and the introduction of the "chess-board" system of deferred grazing.

(b) All crops to be planted on ridges made on the contour.

(c) Soil conservation and pasture development by bush clearing, contour banking and grass planting with tax-defaulter labour as available.

The necessary township and Native Authority rules were passed and the scheme has now been going for two seasons. Of the three measures, the controlled grazing has given the least trouble and probably the greatest benefit. This is surprising as a large proportion of the cattle belong to Somali dairymen, who are notoriously difficult to control, but they as well as the Gogo stock-owners have been quick to realize the benefits; only a few prosecutions have been necessary. Two grazing guards have been found sufficient to supervise the grazing rules, and the system of demarcation seems quite satisfactory.

The cultivation rules have been more difficult to enforce and each year a considerable number of people have been fined for not complying with them. While there is no doubt that the ridges have considerably reduced run-off and erosion, they have by no means been completely effective. Even well-made ridges on quite moderate slopes seem subject to a good deal of damage from heavy storms. Four instructors were used to supervise these rules and have assisted the cultivators by demarcating contour lines in their fields. The crops grown on ridges in both seasons compared favourably with those grown on the flat outside the controlled area.

Progress has also been made in clearing land of bush, in contour banking and in grass planting. In 1939-40 some 350 tax defaulters cleared 600 acres of bush and planted it up with Star-grass. In 1940-41 about the same number of defaulters were used to clear a further 300 acres, plant and contour bank a portion of it and maintain the previous year's clearings.

Thus results from the scheme are already becoming apparent and there is every reason to hope that it will afford a good demonstration of a better system of land use for this arid and easily eroded region.

Deferred Grazing.—In addition to these two schemes efforts have also been made to improve matters more generally in the district by encouragement of deferred grazing, of contour ridge cultivation and of manuring. Of these the most progress can be recorded under the first and some quarter of a million acres of grazing land are being reserved in some form or other (as a preliminary to a definite system of management) for dry season use. Requests have been received from Chiefs for assistance in the demarcation of these reserves and generally they have been most helpful in supervising them.

Ridge Cultivation.—Little headway, however, can be recorded in the general introduction of ridge cultivation amongst the Gogo. With the increased staff made available for the increased production campaign of 1939-40, a vigorous attempt was made to encourage this method of cultivation. Native Authority rules were issued requiring all cultivators to plant a proportion of their crops on ridges. With European staff a good deal was achieved, particularly alongside roads. But the following year when the enforcement was of necessity left largely to chiefs and headmen, little attention was paid to the rules.

Contour Banking.—Four demonstration areas of contour banking and gully stopping, covering some seven hundred acres of land, were carried out in March and April 1939 as an anti-famine measure in southern Dodoma district. These are the chiefdoms of Matumbulu, Mvumi, Handali and Makangwa, and the work done was paid for in grain. These areas have been kept as grazing reserves for dry season use. Most of the gully stops no longer function and the banks made were on the small side, but unfortunately labour has not been available to increase their size or for maintenance.

MANYONI

Soil erosion in this sub-district is not so serious as in the more densely populated areas and apart from the encouragement of ridge cultivation in the 1940-41 season, with excellent results in the vicinity of Manyoni itself, little has been attempted there.

KONDOA

Erosion in the populous Irangi chiefdom of the Kondoa district has been already referred to and is so spectacular that most people tend to consider the position there as past redemption. Personally I am inclined to think the problem rather easier than in Ugogo for two main reasons: (1) the people are more amenable, intelligent and industrious and are under strong tribal rule; and (2) the climate is more suitable for the growth of soil-binding perennial grasses and the control of regeneration of bush is not such a difficult problem.

The first real attempt at an anti-erosion demonstration was the development, started in 1933, of a small Demonstration Stock Farm by the Veterinary Department. Much of the land used was typically sheet- and gully-eroded, but with proper pasture management all erosion was stopped, the soil became well protected with grass and capable of carrying a beast to under three acres of land.

This was followed in 1938 by the demarcation by veterinary staff of the first grazing reserve for dry season use. This covered an area of some 5,000 acres of land in the chiefdom of Mondo, where some of the worst erosion was taking place. The benefits of this reservation in encouraging grass growth impressed the chiefs and people greatly and in the following year no difficulty was experienced in obtaining their support to demarcate three further large reserves. In 1940 it was hoped to divide up these large reserves in blocks in order to start a system of deferred grazing, but this unfortunately had to be abandoned owing to lack of staff as the Crop Supervisor, stationed there since the outbreak of war, was required elsewhere.

Ridge Cultivation.—Some attention has also been paid to the encouragement of ridge cultivation and Mr. Savile laid down demonstrations in a number of areas. An impetus to this anti-erosion work was given by the 1939-40 increased production campaign when a special Crop Supervisor (Mr. D. A. Fletcher) was seconded for the Kondoa area. The efficacy of the ridges, however, was partly nullified by a tendency to make them too small and not sufficiently on the contour.

Kondoa Reclamation Area.—In 1940, the Provincial Commissioner (Mr. R. A. J. Maguire) sought my views on whether reclamation was not possible at Kondoa along the lines which were proving so successful around Dodoma and at Msamalo. In my

opinion there is every chance of success if the problem is approached in the right way. Therefore a scheme was drawn up which included controlled grazing, contour banking, grass planting and the enforcement of cultivation rules. In regard to the latter the aim is to terrace all cultivated land rather than encourage ridge cultivation, as the conditions at Kondoa are considered suitable to permit of terrace banks being effectively maintained. The area selected was some 15 square miles around Kondoa station itself. The details of the scheme were explained to Chief Salim of Irangi and his headmen, upon which they promised their full co-operation.

The area was then demarcated by means of earth beacons 150 yards apart and planted with *Euphorbia* and sisal. It was then subdivided into two parts for the purpose of introducing the "chess-board" system of deferred grazing to be described in more detail later in the article.

The funds (£100) provided by the Native Treasury permitted some 300 acres to be contour banked with paid labour working under three trained Agricultural Instructors. This work has stood up to the storms experienced so far, most satisfactorily.

Two instructors with two men to assist them laid out contour lines fifteen to twenty-five yards apart in the fields of all the people (over nine hundred families) living in the controlled area. The cultivation rules require each man to lay the uneaten crop residues on these contour lines instead of burning them as is usual. Thus the contour lines remain well marked until the break of the rains, when large ridges (the size used for planting sweet potatoes) are required to be made along them. By retaining these ridges and increasing their size from year to year, it is hoped eventually to form level terraces held up by grassy banks.

It is too early to say how successful this reclamation scheme will be except that I am well satisfied with the progress made so far; the only difficulty has been in connexion with the enforcement of the cultivation rules.

SINGIDA

As mentioned previously, this district is fortunate in having been under the Administrative charge, since 1937, of Mr. A. W. Wyatt, an officer who has made a special study of anti-erosion work. During this period much has been accomplished in his area.

SOIL EROSION IN THE CENTRAL PROVINCE OF TANGANYIKA TERRITORY



A typical example of erosion of the red earth fan slopes under secondary bush in Ugogo, due to previous cultivation followed by continuous grazing. The small tree (Sapium sp.) with its roots exposed is certainly not more than ten years old.

Plate by courtesy of Dept. of Veterinary Services, Tanganyika Territory.

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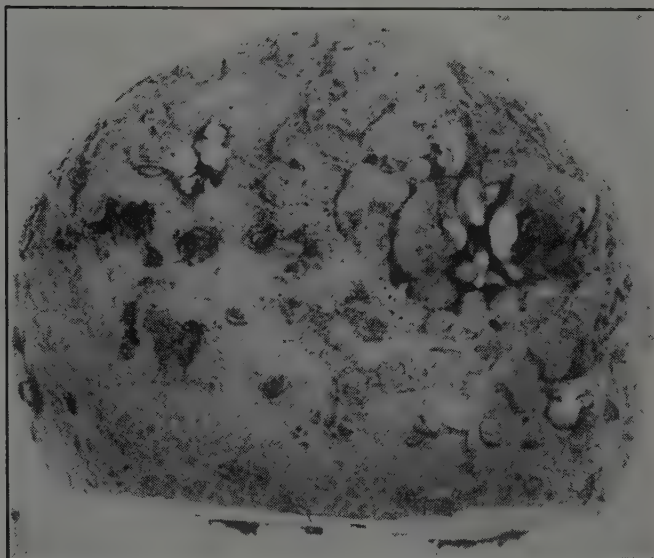
SOIL EROSION IN THE CENTRAL PROVINCE OF TANGANYIKA TERRITORY



Photograph showing the prevalent condition of accelerated soil erosion due to overstocking and faulty cultivation methods in parts of Kondoa-Irangi district.

Plate by courtesy of Dept. of Veterinary Services, Tanganyika Territory.

POTATO DISEASE



Potato Tuber showing early and late stage of Eelworm attack.

In 1938, in collaboration with the Agricultural Officer (Mr. A. H. Savile), the first large scale anti-erosion demonstrations were inaugurated at Kinyangiri and Kititima. The measures used were the construction of graded contour banks (with the furrow on the top side of the bank) and the prohibition of grazing in the areas treated. The demonstrations were so successful that the work has been greatly extended with both Native Treasury funds and by the use of a part of the tribal annual labour turn-out. The grazing restrictions have been modified and are now only enforced during the rainy season.

During 1939 and 1940 the Native Treasuries spent some £400 each year in paying labour gangs employed on contour banking. In addition, some 6,000 men of the annual tribal turn-out of labour for ten days were used to construct banks. The work was concentrated mainly in five areas where soil erosion is particularly serious or may become so in the future, viz.:—

- (1) Around Singida and Ikunge in the main Singida open "cultivation steppe".
- (2) On the Iramba plateau on the headwaters of the Rivers Kironda and Zalala.
- (3) Around Kinyangiri on the headwaters of the Pumbaa, Senene and Igangunu Rivers.
- (4) In the Kidaru tsetse clearings to protect newly opened land.
- (5) Around Mgori and Msughaa at the foot of the Rift Wall.

In these five areas about 1,000 miles of contour banks, 8 ft. wide at the base, have been completed in the past three years. Combined with controlled grazing, they have largely reduced the run-off and almost completely stopped soil losses from some 8,500 acres of previously very badly eroding land.

Ridge Cultivation.—During the 1939-40 increased production campaign and since, ridge cultivation has also been actively encouraged with gratifying successes in the Usure and Ushora chiefdoms, where the population contains an appreciable percentage of Wanyamwezi settlers, amongst whom this method of cultivation is customary.

Terracing.—Investigation by the District Commissioner also showed that with the Wanyiramba it had at one time been customary to practise an elementary system of terrace cultivation. This unfortunately for some reason had long fallen into disuse, although the remains of such terrace banks could in places still be seen. At the commencement of the 1940 planting season, he persuaded the Chief to order the resuscitation of this system of cultivation at the annual tribal festival attended by representatives from all over the chiefdom. For generations it has been customary to "broadcast" instructions at this festival by the "rain-maker", whose office has now been modernized into that of chief. The results the first year were most encouraging and cultivators are now being assisted to lay out their terrace banks properly on the contour by trained instructors using striding levels.

Deferred Grazing.—The Assistant Live Stock Officer (Mr. G. Webb) stationed at Singida, has made his contribution by actively encouraging the demarcation of grazed reserves as the preliminary to the introduction of a deferred grazing system. In this work Chief Kingo of Iramba has been particularly helpful and large areas have been reserved on the very eroded headwaters of the Kironda and Zalala Rivers arising on the Iramba Plateau. Mention has already been made of the reservation of all contour banked areas.

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(To be continued)

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NOTES ON PLANT DISEASES

By R. M. Nattrass, B.Sc. Agric. (Lond.), Ph.D. (Lond.), D.I.C., Senior Plant Pathologist, Kenya

EELWORM ON POTATO TUBERS

Most readers are aware of the production of nodules of various sizes on the roots of plants attacked by the root-knot eelworm *Heterodera marioni* and attention has already been drawn to the serious menace to cultivated crops threatened by this parasite in Kenya.

The effect on the potato tuber is very different and few recognize the symptoms as being due to eelworm attack. One stage at any rate is frequently confused with Common Scab to which it bears a superficial resemblance.

Affected tubers are first seen to have a number of smooth, rounded swellings or nodules on the surface. These are usually not more than 3-4 mm. in diameter. In the tissue of these nodules numbers of active eelworms can easily be seen under the microscope but are invisible to the naked eye. They can usually be recognized with the aid of a pocket lens by cutting a nodule down the middle where in the centre of the tissue a small translucent speck can be seen. In a later stage of development the swellings collapse, leaving scab-like lesions on the surface of the tuber. It is probable that a cork layer is formed beneath which in due course prevents the eelworms from obtaining further nourishment. The illustration of part of a tuber shows both stages of the disease.

The danger of contaminating clean land has already been stressed, as eradication is diffi-

cult and few crops are resistant. No tubers, therefore, showing any signs of eelworm attack should be used as seed, especially in gardens where a succession of susceptible plants is likely to be planted.

There is no satisfactory way of treating affected tubers, but as the region invaded by the eelworms is superficial only even badly attacked potatoes can be used for table purposes.

The effect of the eelworm appears to be mainly on the tubers with little or no nodule formation on the actual roots. The plants, therefore, do not show any symptoms of disease in the field and it is not until lifting time that the disease is noticed. It is, however, likely that if the soil is badly contaminated the roots would also be attacked.

The disease thus differs greatly from the true "Potato Sickness" caused by the potato root eelworm *Heterodera schachtii* which is well known in Europe. Here the roots and not the tubers are attacked so that the growing plants show all the symptoms of a root disease. The disease is not likely to be confused with the above as the encysted female eelworms on the roots can be seen with the naked eye as small white and, later, brown spherical bodies. This eelworm has fortunately not, so far, been found in Kenya.

AN AUSTRALIAN EXAMPLE OF EROSION AND RECOVERY

The disturbance of a natural balance, with consequent harmful results to bird life, was exemplified in a very interesting way on Phillip Island, off the Victorian coast, where conditions were ideal originally for the breeding of mutton-birds, and several large rookeries existed, each of some hundreds of acres. It appears that the main rookery on the south-eastern point of the island was at one time well timbered and this, together with the coastal banksias, tea-tree and other scrub, afforded fine protection. In later years, however, the rabbit was introduced, and with the resultant deterioration in the pastures and the introduction of goats, the landholders resorted to the usual wasteful method of burning to try and improve their pastures. The trees all died out, and the scrub disappeared, until finally the area became covered with bracken. This was fired repeatedly, with the result that

soon the sand began to shift, and on the south-west side of Cape Woolamai the whole surface was blown away to a depth of six feet, exposing to view, on the hard limestone foundation, the bottoms of the nesting burrows of the mutton-birds, which had probably used the locality for hundreds of years. Steps were then taken by those who had the welfare of the birds at heart to prevent sand drift and preserve the area as a breeding site.

At the Cape, which was the main rookery, we commenced planting marram grass about seven years ago. With the co-operation of the owner these plantations were fenced off, and in twelve months the main sand drifts were stopped and we could say that the place was saved. Every year since this, planting has been continued with most beneficial results.

F. E. Lewis, Chief Inspector of Fisheries and Game, Victoria, quoted in *Emu*.

NARROW-BASE RIDGES FOR EROSION CONTROL

By G. B. Masefield, M.A., A.I.C.T.A., Soil Conservation Officer,
Buganda Province, Uganda

Narrow-base ridges—locally known as “bunds”—have been in use for some years in different parts of Uganda, and it is now possible to assess their usefulness for erosion control.

Ridges of this type were widely constructed in the United States in the latter years of the nineteenth century for preventing wash, but since then they have been ousted from favour by broad-base terraces of the Mangum, Nichols, and other types, and this applies to most countries where cultivation is carried out by implements. American text-books now speak of them as practically obsolete. However, they are still recommended in parts of India, and in Uganda they have been found of use within certain limits—particularly in areas where cultivation is entirely by hand, where the cattle population is low, and on the steeper slopes.

Bunds versus Stop-wash Hedges

In such areas, in fact, bunds have under Uganda conditions only one serious competitor for the same purpose, namely stop-wash hedges, of which elephant grass (*Pennisetum purpurem*, Napier grass) appears so far to be the most useful. As against these, they have one great advantage, that once made they accomplish a more complete prevention of erosion with less maintenance work, and for this reason they are probably to be preferred where very steep slopes have perforce to be cultivated. In Buganda, for example, cases have occurred even in areas which are being treated as models for soil conservation, where owing to pressure of population cultivation has to be permitted on slopes up to 30 per cent steepness; and in such cases bunds seem to be preferable to hedges.

On the other hand, compared with hedges, bunds suffer from a list of disadvantages which may be tabulated as follows:—

(1) Bunds are more expensive to make. The cost is about 1 cent per yard in Buganda, and another cent per yard may be spent in planting them with grass. Elephant grass hedges, with a well-trained gang, may be planted for as little as three-tenths of a cent per yard. Assuming an interval of 20 yards between either bunds or hedges, the costs would work out at Sh. 4/84 per acre and

Sh. 0/73 per acre respectively for protecting land from erosion with grassed bunds or with hedges.

(2) In areas where the live stock population is heavy, gaps are quickly knocked in bunds, particularly by cattle on their way to pastures or water. With some forms of hedges, cattle are not so inclined to walk through them (though elephant grass hedges sometimes suffer from grazing); and in any case gaps are more undesirable in bunds than in hedges because of the danger of gully formation. In Uganda this trouble has been chiefly experienced in the Eastern Province; in that area where there is a high live stock population, ploughs are widely used, and slopes are mostly gentle, bunds have ceased to be recommended for general use, and erosion control is by strip cropping with belts of grass between the strips.

This disadvantage of bunds may be to some extent countered by planting thorny hedges along them; Mauritius Thorn, *Erythrina abyssinica*, *Harrisonia* and *Commifera* would appear to be suitable in different climates of Uganda. In special cases, for example, where bunds cross house compounds, pineapples planted on them have been found useful to prevent depredations of children or goats.

(3) Bunds are more liable to break than hedges if low places occur, because whether graded or level they hold up the whole of the run-off which finds its way along to the lowest spot, makes a gap and forms a gully. To guard against the danger of breaks, inspection of bunds must be more frequent than that of hedges, and repair work if required will be more urgent.

(4) Because of the dangers attached to any possible low spots, much more accurate surveying is necessary for the construction of bunds than of hedges, with the consequent necessity for skilled and expensive staff. Contour hedges can at a pinch be put in by eye; for bunds that are to be permanent a fairly accurate levelling instrument must be used.

(5) Bunds are so expensive (or in the case of the smallholder, take so much time) to make that when a certain number of a man's plots have been protected in this way he is tempted to go on cultivating them for ever instead of allowing them the necessary resting

period under grass, during which he cannot see that his bunds are doing him any service. This may be a serious disadvantage with the native agriculturist, whom it is in any case difficult to persuade to rest his land for long enough periods.

(6) A disadvantage sometimes instanced against bunds is that they detract from the yield per acre by putting a proportion of the land out of cultivation; this varies according to their own width, and the interval at which they are set. In addition, a good deal of the fertile topsoil is scraped up to make the bund; and where bunds are made through permanent crops such as bananas and coffee, these may have their roots exposed and suffer in consequence. I do not consider, however, that this is a real disadvantage as against hedges, since the latter by their root competition also reduce the yield of the crops adjoining them. There is probably no stop-wash measure which does not reduce the yield of the crops by a small amount in order to save the larger loss by erosion.

From a consideration of this list, it will be evident that hedges are likely to be preferable to bunds in the great majority of cases where narrow stop-wash lines are required in native cultivation in Uganda. Bunds are still useful in the limited circumstances mentioned above; and in describing details of their construction special reference will be had to Buganda, a province in which these circumstances sometimes obtain.

Level or Graded Bunds

When some of the early bunds were made in Uganda, it was not known how much surface water they might be expected to hold up, and they were made with a slight gradient by which the water would be drained to one end and discharged through a properly controlled channel. While this might still be necessary, were bunds to be made in certain parts of Uganda, it has now been found that on agricultural land under normal conditions of soil and rainfall in Buganda hardly any surface water will lie above bunds even in the severest storms, and consequently the present practice is to make them level. In exceptional places, however, as where a bund crosses a small hollow, or is affected by the run-off from a footpath, roof, or house compound, water may collect above it in some quantity. Taken in the aggregate, these exceptional places amount to a surprising number in thickly-populated areas, and it may sometimes be necessary to divert or absorb the water in

order to ease the pressure on the bund. Some examples of this in practice are as follows. In one place a spring was found to break out at every season of heavy rain just above a bund, and repeatedly broke it; a well was dug on the spot, provided the people with a useful supply of water during many months of the year, and saved the bund. In another case the run-off from a footpath was constantly breaking a bund; a diversion ditch was made to carry the water into a banana garden which was kept mulched and where the soil absorbed it without any trouble.

Intervals Between Bunds

In Uganda the vertical drop has generally been used for measuring the intervals between bunds, and drops varying from 9 inches (on flattish land in Teso) to 8 ft. (in the hilly district of Toro) have actually been used. The desirable interval will depend largely on the degree of terracing which is expected to take place. If, for example, it is expected that perfectly level bench terraces will in the course of time be formed along the lines of the bunds, it is probable that a terrace wall of more than say 4 ft. high will not be able to support itself without masonry, and therefore the drop should not be more than 4 ft. Actually the degree of terracing observed varies a good deal, and in Buganda seems somewhat surprisingly to be greater when the bunds are closely spaced at a small drop. The greatest amount of terracing seen in this province was in bunds in experimental mulched coffee plots at Kawanda at a drop of 2 ft., and in bunds on plots cultivated by natives at Bukalasa at a similar drop. In the latter case, the bunds had been planted with *Paspalum* grass, and this had risen with the rising earth and still formed a satisfactory line which prevented any over-spilling at the edge of the terrace; these observations were made when the bunds were 18 months old. The bunds referred to at Kawanda were several years old, and bare; earth had been heaped up on them from below every year, without which it is probable that there would have been over-spilling.

In other cases, less terracing has taken place. At Kawanda Experiment Station no noticeable terracing took place over several years with bunds at a 4 ft. drop, though this may be due to the fact that the strips between them were more often under a grass fallow than under crops during the period concerned. From Toro, in one area only a slight tendency for soils to accumulate on the upper side of

bunds was reported with bunds at a drop of 7-8 feet and an easily erodable soil; in another area, a distinct terrace formation was noted.

On the whole I think that a vertical drop of 6 ft. can safely be recommended for general use with bunds in Buganda; in other areas this might have to be varied according to the type of soil and prevalent slopes. On slopes of 10 per cent, which are about the average in the more thickly-populated parts of Buganda, a drop of 6 ft. will give a strip of 20 yards wide between bunds. Conversely, in cases where there is any difficulty in measuring the vertical drop, a 20-yard interval between either bunds or contour hedges may be generally recommended, with perhaps 25 yards for particular areas of Buganda where the slopes are less severe.

This latter method of measurement is, however, not recommended. Some text books outline a system whereby the interval between ridges is found by the surface measurement of a strip whose width is calculated by a formula (several different ones are advocated) from the prevailing degree of slope. However this may be for countries with smooth regular slopes, it has been found quite unpractical in Buganda. After measuring off the width of strip given by the formula, one often finds oneself starting one's contour line in a local hollow or protuberance, with the result that after taking a few sights one's line is running unduly near to or far from the adjacent bund.

Size of Bunds

It is sometimes stated that even narrow-base ridges should not have a base less than 5 ft. wide. This in my opinion means too large a structure for the native to be expected to make for himself. Bunds 3 ft. wide at the base and 2 ft. high in the centre, when freshly made, have proved quite satisfactory in Buganda, though perhaps the base should be broadened to 4 ft. if lighter soils are met with. Bunds may be expected to sink about one-sixth of their height as the earth settles (those made by hand are said to sink more than those made with plough or grader), so that these dimensions would result in a final bund 20 inches high—just possible for a person to jump, which is an important factor in preventing damage by walking on them.

Permanent bunds which are to be planted with grass should not, in my opinion, be smaller than this; but there is a possible use for smaller bunds, say only 1 ft. or even 10 inches high. Such bunds could be quickly made across the

slope by cultivators when hoeing their plots, and should be at much closer intervals, say 10 yards or even less. They would be left bare, not planted, and if any breaks occurred they could be quickly re-made. They would soon disintegrate, and would have to be rebuilt every time the plot was cultivated. Their advantage would be that they would not need to be made with a level; any low places would become obvious after a few rains, and the people could remake them on a better alignment without too much labour. Such small bunds would appear likely to be popular with cultivators, and have in fact already to a considerable extent "caught on" in Masaka District.

Building from Above or Below

Much controversy has arisen with both the narrow- and the broad-based ridge as to whether the earth used in construction should be taken from above or below. The first argument is that by moving the earth from below one is decreasing the gradient of the slope and contributing to the process of level-terracing; a ditch above the bund does the opposite. On gentle slopes this seems to be the strongest argument, and one should probably move all the earth from below. On the other hand, on very steep slopes, it is argued that the removal of earth from below saps the foundations of the bund, which is liable to collapse under the pressure of water and soil brought down from above; building with earth from above not only removes this danger but leaves a ditch so that the pressure on the bund will come at its base instead of near its top. On such slopes this argument has great force, and the earth should, in my opinion, be moved from above; the ditch which remains on the upper side is in some cases fairly rapidly filled by soil or rubbish washed down from above. On intermediate slopes, it would seem best to take half the earth from above and half from below.

Levelling for Bunds

At least eight different types of levels have been tried on the field scale for laying out bunds in Uganda, and without going into detail it may be said that two have proved themselves outstandingly useful—the Abney level and the road tracer. In Buganda, some instrument of the optical type is essential because one is mostly working either in elephant grass or amongst tall standing crops such as bananas, coffee, or cassava, where there would be no room to swing a striding level. In the open country of the Eastern Province, striding levels have been more used, but have not proved so

satisfactory as the two mentioned above. The most widely used at one time in district work was the A-frame type, locally known as the "clothes-horse level" (described in the *East African Agricultural Journal*, Vol. II, p. 28), but this was too inaccurate for bunds of any length owing to the difficulty of sawing the timber to sufficiently close measurements and to the warping of the wood in use.

Using an Abney level in all types of Buganda country, errors up to 12 inches vertical per mile of line levelled have been experienced, the larger errors being in wet weather when the staffs were muddy, and when passing through thickets and difficult terrain. African assistants, using a dumpy level, reduced the error to about half an inch vertical per mile, but this instrument is obviously too expensive for use on an extensive scale. With the "clothes-horse level" an error of 5 inches vertical in 20 yards is recorded! Such an instrument, however, may be useful for laying short lengths of bunds in individual plots, where it cannot be used for mile-long bunds that are to encircle a whole village. A simplified form of road tracer is now being manufactured locally at a cost of Sh. 15, and it seems likely that this may become the standard instrument of the future.

For bunds it appears safe to take sights at an interval of five paces when levelling; longer intervals are not recommended on the steep slopes on which bunds are used, owing to the danger of sections being off the true contour. In thick cultivation of the type referred to above, it is in fact often impracticable to take longer sights than this and sometimes impossible to see even for five yards. There is of course no objection to a bund running very slightly off the true contour for a few yards to get round some obstruction, such as a tree, provided that in such a case the section of the bund which lies below the rest is strongly banked up and raised in height the necessary inch or two to bring its top up to the true line.

Details of Bund Construction

Bunds can be made with hoes, but where large gangs are employed the work is done faster if a proportion of the men are supplied with spades or shovels. Where ploughs are available the work can be hastened. At Serere Experiment Station it was found that if a strip 2 ft. wide is left undisturbed down the line of the bund to form its foundation, passing the plough twice along one side and back the other is enough to form the body of the bund, which is then pressed down and finished off by hand labour.

The time of year when most labour can be spared from native holdings for improvement works such as bunds is during the dry season. Unfortunately, this is the worst time for the work. Not only is the surface of the soil hard and difficult to break up, but the dry soil does not bind well and keeps slipping down and actually blowing off the bund. The best time to make bunds is when the soil is reasonably moist.

Where a footpath has to cross a bund this should not be allowed to wear it down, but the bund should be paved with stones to form a ramp on which people tread.

Earth is not, of course, the only possible material for making bunds. Where heavily forested or stony land is being cleared, tree trunks and boulders may be used for the purpose. At Kachwekano Experimental Farm it was found cheaper to dispose of trunks, stumps and boulders by building them into bunds than by clearing them off the plots. In such cases inspection and filling up with earth may be necessary to make sure that no wash takes place through intertices.

It should not be necessary to say that in laying out bunds work should start at the top of the slope and proceed downhill.

Planting up Bunds

Many cultivators like to plant crops on their bunds, but this is to be deprecated, because the weeding and harvesting of the crop damages the bund. If, owing to extreme pressure on the land, it is essential to plant crops, these should be the longest term ones, such as pigeon peas, long-standing cassava, pumpkins, or sugar cane.

On the other hand, it is undesirable to leave bunds bare, because they will then form reservoirs of weeds which will spread into the plots between; the couch-like *Digitaria scalarum* is especially to be feared in this respect. In the Eastern Province, where soils are light and very heavy rains often fall in short periods, bare bunds have actually been known to be washed away by the force of the water.

The solution of the problem is to plant bunds with a permanent grass cover, for which the grass *Paspalum notatum* has been found most satisfactory in Uganda. It grows rapidly from divisions and covers the surface of the bunds without becoming a menace in the adjoining plots. It competes successfully with weeds, lasts well, and does not grow tall enough to harbour crop-destroying vermin; this

is an important point, and in some districts is a disadvantage of elephant grass hedges, which may harbour field rats. *Paspalum notatum* fits the bill so well that there is little need to recommend others. However, Vetiver grass (*Vetiveria zizanioides*) is another useful and quick-growing though longer grass; Kikuyu grass (*Pennisetum clandestinum*) would be suitable in the higher districts of Uganda, such as Bugishu and Kigezi. Species of *Cynodon* are

quick growing, but *C. dactylon* and *C. transvaalensis* are not very drought-resistant and tend to die out after a few years, while *C. plectostachyum* often becomes a nuisance as a weed in Uganda. Another introduced grass, *Eremochloa ophiuroides*, shows promise but is not very drought-resistant. Where *Paspalum* cannot be obtained, the best of the indigenous grasses for planting on bunds is probably *Brachiaria decumbens* (Luganda *kifuta*).

(Received for publication on 13th August, 1941.)

REVIEW

REPORT BY MR. J. SMITH, O.B.E. (ADVISER ON ANIMAL HEALTH TO THE SECRETARY OF STATE FOR THE COLONIES) ON HIS VISIT TO EAST AFRICA, April-July, 1941. (Continued.)

Mr. Smith attaches great importance to the work of the African Veterinary Training Centres of the Kenya Department. These centres are largely devoted to the breeding of improved milking strains of native cattle, and to instruction of Africans in the rudiments of animal management and dairying for ghee production. In his view, dairying should be the main stock-farming activity of the African peasant in the agricultural areas, and he visualizes a steady progression by way of ghee production to a more advanced type of dairying in which natives will supply butterfat to creameries engaged in the manufacture of butter for export.

During his tour of the Nyanza Province of Kenya, he appears to have been shocked by the conditions that have arisen from the recent expansion of cultivation in certain of the more fertile areas, and from the progressive restriction of grazing lands to the point at which they are so grossly overstocked that both the animals and the remaining pastures are deteriorating rapidly. He regards stock as a necessity if intensive agriculture is to be practised, but states that the numbers of stock must be reduced and the remainder fitted into the crop-rotation. He points also to the urgent need under these conditions for prompt re-grassing of abandoned shambas instead of leaving them to bare fallow; and on the policy of closing certain portions of the grazing areas to assist their recovery, he makes the pertinent remark that if the total amount of

grazing were sufficient such a policy would be beneficial, but that under existing conditions the closing of one area simply means the concentration of stock upon the remaining area, which is quite unable to support the animals without suffering further denudation.

While he regards the whole of this area as essentially an intensive crop-producing area, his view is that live stock "must be fitted into the farming operations and maintained under conditions which will enable them most efficiently to contribute to the maintenance of soil fertility. Economically, the obvious step is the development of dairying". For some time past the efforts of the Kenya Veterinary Department in this area have been concentrated upon the development of intensive dairying, and this policy has been fully endorsed by the Director of Agriculture and accepted by Government. Some progress has already been made, and with the full collaboration of officers of the Department of Agriculture, it is hoped that in time Africans may be persuaded to keep their dairy cows on their own agricultural holdings instead of leaving them to starve for the greater part of the year on inadequate communal grazing lands.

Mr. Smith agrees that there are possibilities for the development of an export beef industry in certain pastoral native reserves and in the ranching country of the settled area. He doubts if it will be practicable to enter markets for the highest grade beef, and recommends that attention should be paid to the development of markets nearer at hand, where the demand is likely to be less discriminating in the matter of quality.

With regard to the pig industry, he states that the experimental shipments have already shown that Kenya can produce and market in the United Kingdom bacon of acceptable quality, and he fails to understand why a country of cheap labour and cheap foodstuffs should be unable to produce bacon at competitive world prices.

UGANDA

The establishment of local cattle markets is regarded by Mr. Smith as one of the most valuable advances made by the Veterinary Department in recent years. He points on the one hand to the improvement in the diet of the people that must result from the covering of the country with a network of cattle markets, and on the other to the added responsibility which the existence of these markets places upon those charged with the control of contagious disease. The expansion of markets is limited by the smallness of the staff available for disease control work.

Writing of the general position in Uganda, he expresses the view that in the more agricultural districts the introduction of mixed farming is essential to maintain soil fertility, and that the cattle used in these operations should be made as commercially useful as possible. He sees no reason why a dairy industry, concentrating upon ghee manufacture, should not expand side by side with the increasing meat industry.

He remarks upon an apparent lack of co-operation between the Departments of Agriculture and Veterinary Services in the development of live-stock improvement and animal husbandry, and expresses the hope that it will be possible to formulate a policy in which concerted effort will expedite the development which all have in view.

It is, of course, possible that the lack of co-operation to which Mr. Smith draws attention is more apparent than real. There is evidence that a working arrangement exists in Uganda under which pastoral areas are mainly under the control of the Veterinary Department while both departments collaborate in the work in the agricultural areas. In fact, there is already a good deal of co-operation, both directly between individual officers of the two departments, and indirectly through the district and provincial teams, particularly in the development of mixed farming.

Mr. Smith was evidently impressed by the possibilities of educating Africans to something approximating a professional standard in veterinary science, and he refers at some length to the instruction given at the Entebbe Veterinary School to students who have taken the pre-veterinary part of their five-year course at Makerere. He believes that well-trained Africans can be of great assistance in the East African veterinary departments, and that through their agency the scope of the work may be greatly extended, with the release of European officers from the need to attend to matters of detail. He remarks upon the difficulties with which the school is faced at this stage—difficulties that arise from the smallness of the number of students and the need to teach a curriculum covering a wide range of subjects, and recommends that as the number of students increases another educational officer should be appointed, so providing a teaching staff of three, including the Senior Veterinary Research Officer, whose responsibility includes the general planning and supervision of the course.

TANGANYIKA TERRITORY

Mr. Smith was able to spend more time in Tanganyika than in Kenya and Uganda, and his investigation of the activities of the Veterinary Department was in consequence more extended.

Referring to the suitability of Mpwapwa as the headquarters of the Department, he remarks that the movement of headquarters to the laboratory site has had unfortunate effects. Mpwapwa is some ten or twelve miles from the railway, and although urgent matters can be dealt with by telegraph, there is no trunk telephone, and if the Director is called to Dar es Salaam for a consultation he is absent from his office for about three days. In Mr. Smith's opinion, the Director, at Mpwapwa, is out of touch with other efforts in the territory and isolated from administrative, agricultural, medical and other services with which his work is closely interwoven.

As a laboratory site he regards Mpwapwa as excellent, and he refers to improvements that have been effected in the farm area by the clearing of land, planting of Star grass, pad-docking, and careful management of the grazing. Of late years the research work at Mpwapwa has been largely concentrated on the management and improvement of grasslands, and on animal husbandry generally.

With the reduction of the purely veterinary staff and the increase in the demand for anti-rinderpest serum and vaccine, pathological investigations have largely been abandoned, but Mr. Smith considers that the laboratory, with the addition of some extra equipment, should be capable of doing useful work in the investigation of many local problems, and that the work would not overlap with that of the Central Research Institute at Kabete.

Writing of the general position of the live stock industry, Mr. Smith states that the problems are formidable. In his own words, "A huge population of cattle, many of an inferior type and quality, is concentrated in areas with insufficient grazing, and where, in some cases, crop production is being encouraged. There is a total absence of markets sufficient to absorb more than a few of the surplus, and it is small wonder than on more than one occasion I heard the view expressed that cattle were useless." In a later paragraph, Mr. Smith referring to the system of auction sales organized by the Veterinary Department, says, "The most recent estimates place the numbers of cattle disposed of at the sales as 100,000 head." Since Messrs. Liebig's (Kenya) Ltd. alone have purchased 128,358 head in the Tanganyika stock markets during the last twenty months, it is probable that the estimate of 100,000 head per annum is on the low side, and most workers in East Africa would say that more has been done in Tanganyika to inculcate the practice of marketing surplus cattle than in any other East African territory.

After expressing approval of the efforts of the department to increase the production and improve the marketing of ghee for export to the United Kingdom, Mr. Smith goes on to envisage the eventual possibility of developing an export butter industry on the lines of the Kenya dairy industry.

Mr. Smith states that, as far as he was able to ascertain, the Agricultural and Veterinary Departments have no concerted and correlated plan for the development of agriculture in Tanganyika, and that they are working separately and independently upon a problem which cannot possibly be solved without active co-operation by both. Similar strictures were passed by Mr. Smith in respect of the work of the departments in Kenya and Uganda, apparently with little foundation in fact, and one begins to suspect the existence of an *idée fixe*. There may, however, be some justification for the charge in Tanganyika, since the Director of Veterinary Services at all

events shares Mr. Smith's views as to the unsuitability of Mpwapwa as headquarters for the department, and voices similar objections with regard to its effect in isolating the department from contact with other technical departments.

When considering the possibility of improving the position of the live stock industry in the territory, Mr. Smith is driven to contemplate the creation of some organization to dispose of large numbers of scrub stock as a preliminary to the improvement of the remainder. His solution is the establishment of a fertilizer factory or factories on the lines advocated some years ago in Kenya, and he cites the Nairobi Municipality plant as an illustration of how such an undertaking can be made to pay its own way. Stockowners in Kenya would hardly regard his choice of an example as fortunate, and experience in Kenya indicates that having regard to the difficulty of inducing native stockowners to part with marketable stock at an economic price, further proposals on the grand scale to turn enormous numbers of scrub animals into fertilizer and tallow are hardly likely to prove acceptable to the East African Governments.

RINDERPEST CONTROL

According to the report, the main object of Mr. Smith's visit to East Africa was to discuss "the possibility of obtaining such a measure of control of rinderpest in East Africa as would allow of some development of the cattle industry as a whole." A section of the report, amounting to four pages, is devoted to this subject, and Mr. Smith reviews the progress of events in Southern Tanganyika from the beginning of the southward extension of infection in 1936 up to the time of the Dodoma Conference in 1940. Most of the information has already been made available through the medium of the press. Mr. Smith agrees that, although general measures for the eradication of the disease from East Africa cannot be taken in war-time, it would nevertheless be a great mistake to relax control measures in any of the East African territories. He points to the danger that arises from extensive stock movements necessitated by the war effort, recommending that constant vigilance should be exercised, and that, wherever possible, local control measures should be increased in order to maintain the present degree of security. He is fully alive to the fact that measures taken now in Tanganyika may well facilitate the success of future operations directed to the eradication of the disease.

FURTHER OBSERVATIONS ON POULTRY

By M. H. French, M.A., Ph.D., Dip. Agric. (Cantab.)

(Adapted from Part II, Annual Report, Veterinary Department, Tanganyika, 1939, the publication of which is held up owing to war economies.)

The following observations continue a previous article¹ which dealt entirely with pure-bred fowls in this Territory and summarize detailed results obtained with native and first-cross European and native birds. There is also a section dealing with growth rates of different types of birds and another with the storage of eggs so as to reduce deterioration in quality.

Native Fowls

The fowls of this Territory are small and multi-coloured and, under the normal native management and conditions, mature late, lay a poor number of little eggs and yield small carcasses. With the exception of a few more progressive owners near towns, the natives keep their fowls in small flocks with no attempt at under intensive or even good conditions. In some areas eggs are not eaten at all, while in others they are considered as fit only for women and children. Fortunately, this prejudice against eggs is slowly being broken down.

The usual method of keeping poultry is to let them find their own food and water and roost where they can in the family hut. Under such conditions it is not surprising that egg-yields are low and mortality rates high, so that a high proportion of the eggs laid have to be used for hatching to maintain flock numbers. Not only do the young birds develop so slowly that they are for a longer period exposed to attacks from hawks but other kinds of vermin take a steady toll of both adults and young, whilst the losses from diseases are occasionally so high that the entire fowl population is wiped out from a group of villages.

To estimate egg yields under native conditions is most difficult because (a) the hens spend a large proportion of their time hatching or rearing chicks, and (b) the hens lay where they wish and many eggs are never found or are eaten by vermin. A rough estimate is, however, in the region of 50 eggs per year.

It was therefore decided to collect a flock of native birds and to select an improved strain for issue to those areas of the Territory where the keeping of the larger domestic stock is prevented by tsetse-flies and where the demand for meat and protein is high. A good strain of native birds was considered to have more

chance of success in arid areas than pure or grade European birds, because the latter would not be adequately cared for.

Absolutely typical native birds were purchased at random from local Wagogo and were given good feeding and management. The egg yields were very encouraging, and 10 per cent of the birds laid over 150 eggs in their first laying year. The average egg yield was 118, with an average weight of 38.4 gm. (1.37 oz.). This yield is much higher than the estimate for native conditions, but these recorded birds were not allowed to sit, though they went broody at intervals. About 17 per cent were culled because of persistent broodiness before they had completed a year's laying.

Not only was there great variation in the egg yields of these birds but the egg weight varied considerably. Certain individuals persistently laid eggs of 30-34 gm., whilst another bird laid eggs from 45-56 gm. There is every reason to believe, therefore, that much could be done to select for improved yields and greater egg weights.

The progeny of these native birds, when reared alongside European chicks, matured much earlier than under native conditions, and pullets began laying at from 6 to 8 months old.

Occasionally one sees bare-necked native-owned fowls which are slightly heavier than the normal type. These birds, though not very attractive to look at, are greatly prized by their owners. A number were purchased to see if they were superior to the ordinary native hen, but the experiment terminated before a complete year's egg records were obtained, because all but one of the bare-necked hens were stolen. The results, so far as they go, suggest that the bare-necked strain laid no larger nor any more eggs than the normal type. Their attractiveness in native eyes is to be attributed solely to their bare-necked character. Just as certain natives will breed from bulls with abnormal anatomical features, so a featherless neck becomes a character for selection in their poultry.

Not many progeny were obtained from these bare-necked hens, but even with Rhode Island or White Leghorn cocks the bare-neck appeared in the progeny.

¹ East African Agricultural Journal, Vol. VI (2), p. 109.

First Cross European and Native Fowls

Half-bred White Leghorn pullets have averaged 170 eggs in their first laying year, with an average weight of 46.9 gm. Half-bred Rhode Island pullets in the same period recorded 162 eggs averaging 45.0 gm. These figures suggest that the half-grades gave egg records and weights which are approximately half way between those of the parent types. Some birds in each group laid very well, the best yearly yield being 248 eggs.

The half-grades grew satisfactorily and the pullets began laying at 6 to 7 months old. They also appeared more tolerant of the heat than pure European birds, and were more active searchers for food in the middle of the day. The shell structure of their eggs was good, even in the case of the grade White Leghorns where the eggs from the pure European ancestors were characterized by their thin shells.

The following figures of comparative average daily food consumptions are of interest:—

Native hens: 2.1 oz.

Half-grade White Leghorns: 2.3 oz.

Half-grade Rhode Islands: 2.7 oz.

Pure White Leghorns: 4.25 oz.

Pure Rhode Islands: 4.50 oz.

Natives prefer the Rhode Island cross to the White Leghorn cross. It was at first thought that this was due to their greater size, but a number of other factors are involved. The natives say, and I have proved it true, that they dislike a white colour because the young chicks show up too plainly and consequently suffer

most from hawks and other vermin.¹ In some districts, such as Ufiome, there is marked preference for red cocks, a fact connected with certain tribal ceremonies.

The Growth Rates of Different Breeds of Chicks

It has become apparent that the live-weights and size of mature pure-bred birds decrease with each succeeding generation of birds raised in this country. The bodies become "light" and, especially amongst cockerels, the legs appear long. It was decided to determine the rates of growth from hatching until maturity for pure White Leghorns, Rhode Islands and native birds and also for European Native crosses. Weight records have been made for half-grade birds made by crossing European cocks with native hens, but the reverse cross has not been studied because it has not so far been possible to produce any such chicks. Whether this has been because the native cocks were not large enough to fertilize the European hens or whether they were merely uninterested has not been ascertained.

In the accompanying table the "hatching weights" are the weights at two days old, when the chicks were removed from their incubators. The weights of males and females are given separately from the third month, and the figures in brackets show the number of birds weighed. The table is incomplete, and insufficient birds have been weighed in the later age-groups, but the experiment was terminated prematurely when I went on early leave.

¹ A similar "natural selection" operating against white birds has been demonstrated experimentally in the U.S.A.—Ed.

TABLE I

WEIGHTS (IN GM.) OF FOWLS OF DIFFERENT AGES AND BREEDS

Hatching weight	RHODE ISLAND RED		WHITE LEGHORN		NATIVE	
	Chickens		Chickens		Chickens	
	(100) 37.1	(131) 141.7	(112) 36.0	(81) 137.5	(194) 21.2	(164) 107.3
1 month	(106) 383.6		(89) 370.0		(118) 270.2	
	Males	Females	Males	Females	Males	Females
3 months	(58) 773.5	(46) 686.4	(37) 757.7	(42) 633.3	(56) 687.0	(72) 503.3
4 "	(42) 1,169.6	(42) 1,003.0	(28) 1,095.9	(31) 948.3	(37) 992.6	(51) 793.2
5 "	(34) 1,591.9	(35) 1,332.9	(11) 1,478.6	(48) 1,203.5	(25) 1,347.7	(32) 1,066.0
6 "	(32) 2,011.5	(31) 1,558.8	(15) 1,677.5	(19) 1,442.0	(21) 1,647.8	(12) 1,303.5
7 "	(26) 2,294.4	(14) 1,840.0	(13) 1,782.6	(12) 1,518.6	(14) 1,854.2	(8) 1,485.4
8 "	(24) 2,501.0	(10) 2,140.0	(9) 1,959.5	—	(10) 2,100.7	—
9 "	(15) 2,613.2	—	(7) 2,066.2	—	—	—
10 "	(18) 2,811.1	—	(5) 2,108.2	—	(6) 2,258.5	—
11 "	(12) 2,925.6	—	—	—	—	—
12 "	(10) 3,090.4	—	—	—	—	—

The figures in brackets indicate the number of birds recorded.

TABLE I.—(Contd.)

	HALF-GRADE RHODE ISLAND RED		HALF-GRADE WHITE LEGHORN		WHITE SUSSEX	
	Chickens		Chickens		Chickens	
	Males	Females	Males	Females	Males	Females
Hatching weight	(137) 25.4	(50) 24.3	(25) 116.3	(28) 349.3	(23) 138.4	(22) 496.7
1 month	(36) 119.6	(31) 354.8				
2 months						
3 months	(8) 747.2	(13) 602.8	(17) 735.3	(10) 578.5	(8) 883.1	(9) 820.1
4 "	(6) 1,072.2	(6) 916.1	(6) 1,065.8	(11) 889.4	(8) 1,509.2	(3) 1,136.7
5 "	(3) 1,453.0	(4) 1,178.2	(5) 1,423.7	(6) 1,090.0	(5) 1,984.6	—
6 "	(3) 1,789.6	(3) 1,427.0	(3) 1,689.0	(4) 1,400.8	—	—

The figures in brackets indicate the number of birds recorded.

The chicks of the different breeds were all fed and managed in the same way and often in the same groups. From the incubators the chicks went to brooders, and thence to small pens at 1 to 1½ months old. At three months the cockerels were separated from the pullets, and all were put under range conditions. The following food mixtures were fed according to appetite:—

	To Chick	To Birds over three months old
	Per cent	Per cent
Maize meal	52	50
Millet	20	20
Cake	13	20
Meat meal	13	6.5
Bone meal	1	2.5
Salt	1	1

If the Mpwapwa figures for pure-breeds are compared with other published figures from Britain and America, it is seen that the former are the lighter at every age, and this applies to both sexes and both breeds. The Rhode Islands of both sexes show growth rates parallel to, but smaller than, those of the same breed in temperate regions up to six months old. After that age the local strain lags behind and the weights for mature birds are below the breed normal.

The White Leghorns lag behind from the fifth month; above this age live-weights are disappointing, and mature birds are proportionately much smaller than the Rhode Island Reds.

The growth rates of native birds cannot, of course, be compared with other published records, but are considered satisfactory, especially as they are much superior to the rates under native management conditions. Compared with the White Leghorns the native cocks are ¼ lb. lighter at five months old but ¼ lb.

heavier at seven months, and similarly the native pullets are ¼ lb. lighter at five months but make this up by the sixth month.

The growth rates of grade birds are intermediate between those of the parent breeds.

This tendency of European breeds to go light in body development is very important, and recalls similar troubles with cattle and sheep. It means that fairly frequent introductions of fresh blood from Europe are necessary if constitution and live-weight are to be maintained. There is a tendency for egg weights to decrease with each succeeding generation (*see* previous article), and this is possibly a result of the diminishing size. This work on growth rates again emphasizes the importance of breeding for constitution in hot climates.

The Storage of Eggs

In Tanganyika Territory, with its high (and often dry) atmospheric temperatures, eggs deteriorate in quality more rapidly than in temperate or cold areas. The quality of eggs is greatly influenced by their treatment by producers and retailers.

In fertile eggs the embryos begin to develop when their temperature rises above 68° F., and the rate of embryonic development increases as the temperature approaches that of incubation. The mean maximum shade temperature over most of this Territory is above the lower limit of embryonic development, which means that eggs lying in nest boxes, stored in ordinary rooms and transported in hot railway trucks may attain a good measure of germ growth. The easiest way to eliminate troubles of this kind is to market only infertile eggs. Many people imagine that it is necessary to keep a cockerel with hens if the latter are to lay properly. This is quite untrue, and eggs for table use are best collected from pens with no male birds.

The "candling" of eggs should be more frequently used as a check on the interior quality of eggs, because valuable information can be obtained by this simple test. Many types of equipment can easily be home made, the only essential feature being a light that can be shone through the egg towards the operator. Viewed in this way, an egg should show no germ development and the yolk should appear as a faint shadow in the centre of the egg. During storage the egg white deteriorates and loses viscosity so that the yolk is able to float about. In stale eggs the yolk floats nearer to the shell and casts a darker shadow than in fresh eggs. In fresh eggs also the air space is small, but on storage this gets larger, owing to the shrinkage of the egg contents due to evaporation of moisture through the shell.

Loss of moisture, by itself, is but a minor form of deterioration, but unfortunately it is usually accompanied by other forms of deterioration, and eggs with large air-spaces should be viewed with disfavour.

Eggs were stored under different conditions for three weeks at Mpwapwa, and it was found that the least loss in weight occurred when eggs were kept in a refrigerator, but few producers can afford to do this. The next best result occurred when eggs were stored in a charcoal cooler, i.e. a box surrounded by a wire-netting frame containing an 8-inch layer of charcoal which was kept moist. Storage in this type of cheap cool box is very satisfactory. Eggs stored in a normal and a warm room lost weight very much more rapidly and this loss was further increased if a draught of air played on the eggs. Losses were also much higher in the dry season than during the rains.

Measurements of the size of the air-space, the yolk index and the amounts of yolk and thick and thin albumen showed that shrinkage of the egg contents was accomplished by absorption of water by the yolk from the surrounding albumen, causing great stretching of the vitelline membrane and failure of the yolk to stand up when emptied on to a plate. The yolk membrane became very fragile as a result of this stretching during storage, and when eggs which had been stored under poor conditions were opened many yolks broke. It was also shown that the increased watery white condition of badly stored eggs is due to an increase in the proportional amounts of thin albumen at the expense of the thick albumen.

Therefore to maintain egg quality it is necessary to (a) collect eggs at frequent intervals from the nest-boxes, (b) spread them out to

cool in a cool room, (c) store them in egg-boxes in as cool a place as possible and away from draughts, and (d) sell the eggs as quickly as possible.

Seasonal Variations in Egg Yields

In the previous article I gave figures of the egg-yields of first-generation pure-bred European birds. It was found that there was a general resemblance between the curves of egg production and the average daily hours of sunshine, though exact correspondence was not obtained. It was also found that maximum egg yields were confined to the period of lowest mean maximum shade temperatures, and that as the mean maxima increased egg yields fell. There was no gradually increased egg output as the temperature fell in the autumn but a sudden rise occurred after the cool season had started.

In Table II comparable results are given for thirty native birds.

TABLE II

SEASONAL VARIATIONS IN EGG YIELDS OF NATIVE HENS, HOURS OF SUNSHINE, AND MEAN MAXIMUM SHADE TEMPERATURES

MONTH	Average monthly egg yields	Average hours of sunshine	Mean maximum shade temperature
January	9.5	7.70	86.0°F.
February	7.8	6.35	85.1°F.
March	8.7	5.95	82.4°F.
April	8.0	5.35	79.7°F.
May	11.0	4.80	75.2°F.
June	8.7	7.30	75.2°F.
July	9.7	8.15	77.0°F.
August	8.5	8.55	77.0°F.
September	9.7	9.60	79.3°F.
October	9.0	8.55	82.4°F.
November	8.8	7.60	86.0°F.
December	10.4	7.20	85.1°F.

It is regretted that only a small number of native birds could be examined, but if these results are graphed it is seen at once that there is a striking difference between the shape of this curve and that for pure-bred European birds. The native yields are of course on a lower plane, but show no well-defined seasonal fluctuations. The native hens are apparently less affected by variations in temperature and insolation rate than European birds.

A small number of half-grade birds were also studied and, though the results suggest an inverse relationship between egg yield and mean maximum shade temperature, there were insufficient numbers to study the effect of insolation rate.

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NOTES ON ANIMAL DISEASES

XIII—CALF DISEASES WITH REFERENCE TO MANAGEMENT

In the preceding article of this series the more important diseases of calves were described and it was mentioned in the introduction that calves could contract such tick-borne diseases as east coast fever, redwater and anaplasmosis. These latter diseases received only brief mention since they had been fully described in an earlier article. It is necessary to point out that calves may also die of anthrax and blackquarter, diseases which are more frequently seen in animals over six months of age, and which will be described in the next article of the series. Outbreaks of rinderpest also are quite often restricted to calves on farms where the majority of the adult stock is immune.

Before leaving the question of calf diseases, it is proposed to discuss briefly the different systems of calf rearing, to point out the danger spots and to describe the steps that should be taken to avoid losses. The system used will of course depend on the economy of the farm and the type of cattle being reared. With cattle raised purely for beef, the system practised is the natural one: the calves are allowed to run with their mothers and to take all the milk that they require. At the other extreme is the dairy herd in which the calves are taken from the mother at birth and are fed entirely from the bucket. Various modifications of them are practised; but by examining these two methods in the first instance, the important points to be observed may be demonstrated.

The Ranching System

It might be thought that under the ranch system calves were reared so close to nature that there would be little or no danger from disease. Unfortunately, however, the percentage of farms on which the fencing programme has progressed sufficiently far to allow of night-paddocking is still low. When a farm is divided up into paddocks of reasonable size and a proper system of rotation of paddocks is practised, there is no necessity for the concentration of stock in small "bomas". The fault in many ranches lies in the concentration that occurs in the boma or at badly-devised watering places. Navel infections, bacillary necrosis and paratyphoid are essentially diseases spread on land fouled by close concentration of the herd. It is only to be expected that wet weather will increase the incidence of these diseases.

Minor points which require watching are the distribution of shade trees and the water supply. An insufficiency of shade trees leads to severe trampling of the soil in their vicinity. The ground becomes boggy in wet weather and, owing to the shady conditions, disease organisms survive for longer than they would on the open veld. Water should be available in every paddock. This may be regarded as counsel of perfection, expensive of attainment. However the land around watering places, even around troughs, becomes very foul if used continuously for long periods and the constant trekking to water leads to the development of cattle tracks which, if on a slope however slight, soon provides a bridgehead for the "arch-enemy", soil erosion. During times when grazing is rather scarce, the provision of water in the paddocks day and night makes a considerable difference to the condition which the cattle are able to maintain.

Hand-reared Calves in Permanent Quarters

In contrast to the ranching of beef calves, the hand-rearing of dairy calves is essentially an unnatural process. The calf is removed at birth and lives an entirely artificial life. Instead of receiving food direct from its dam at frequent intervals during the day it is fed at specified times with milk which may be at the incorrect temperature and may be too little or too great in quantity and altered in quality. Its house may be draughty or stuffy and as it is confined, the floor becomes rapidly soiled if not properly tended. It is obvious, therefore, that hand-rearing demands much more care and attention if losses are to be avoided.

The first essential is a proper calf-house. The construction of such a building need not be a very expensive undertaking. The main points to watch are the provision of an impervious floor, the installation of separate pens, at least for the younger calves, and the admission of plenty of fresh air. The floor need not be of concrete. Murrum, properly packed and covered with a bituminous road surfacing material, gives a good, cheap floor, warm and easily cleansed. A brick floor may also be used. Whatever material is employed, the surface should be given a slope so that efficient drainage can be arranged. Brick, concrete or corrugated iron partitions should be installed to separate the pens. Wire-netting on wooden

frames will serve if it is desired to reduce initial expense; but it is more difficult to cleanse and does not give as efficient isolation as a solid wall. Owing to the necessity for frequent repairs moreover, it is doubtful if much economy is introduced through the use of netting. In regard to the outer walls, a solid structure should be erected on the side of the prevailing wind. The other outer walls may be low (about 3 feet high), the space from the top of the wall to the eaves being filled in with wire-netting or expanded metal in order to keep out vermin. The roof should be sufficiently high to admit plenty of air and sunshine. It may be thatched or of corrugated iron. In places where rain is likely to blow in for more than one quarter a system of movable shutters can be installed. Flattened-out cement drums on a wooden frame are very satisfactory.

Having provided a house we may next consider how to keep it clean. In this connexion it may be pointed out that whitewash is not an efficient disinfectant. The advantage of whitewashing a calf-house is that it enables one to see that cleanliness is being maintained. For actual disinfection during outbreaks of disease, a solution of a coal-tar disinfectant or of chlorinated lime should be employed. For cleansing, plenty of fresh water, preferably warm, should be used. This may seem an unnecessary statement; but in Africa water is not always plentiful and the African does not usually appreciate that there are different qualities.

For bedding, dry grass, hay or sawdust is suitable. Bedding may not be necessary on a tarmac floor in warm districts, but is advisable in most areas, particularly if the calf-house errs on the right side in the matter of ventilation. Long grass easily collected is usually to be found near the cow-house drains and in the more densely-manured paddocks. Obviously, however, such grass is heavily charged with potential disease-producing organisms. Bedding must be changed daily. The true farmer will know the spots on his pasture where the cattle never stay sufficiently long to manure them properly and will dump the used bedding there.

Finally comes the important point of feeding. Hand-rearing of calves can only be successful if a proper system of feeding is adopted and adhered to strictly. Milk should always be fed at body temperature, about 100°F. During the first fortnight or a month, the calf should receive its own mother's

colostrum and milk. Skim milk may be introduced between the sixth and tenth weeks, depending on the value of the calf. The amount of milk that should be fed daily will depend on the size of the calf. The following table may be used as a rough guide, the smaller figure being that required by a small native Zebu calf and the larger that necessary for a pure-bred calf of a large European breed.

First half of 1st week: $\frac{3}{4}$ to 1 lb. whole milk three times a day.

Second half of 1st week: 1 to $1\frac{1}{2}$ lb. whole milk three times a day.

By end of 2nd week: 2 to 5 lb. whole milk twice a day.

By end of 3rd week: $2\frac{1}{2}$ to 6 lb. whole milk twice a day.

By end of 4th week: $3\frac{1}{2}$ to 8 lb.

By end of 5th week: 4 to 9 lb.

By end of 6th week: 4 to 10 lb.

By end of 7th week: 4 lb. whole milk with 1 lb. skim to 8 lb. whole and 2 lb. skim twice a day.

The whole milk may then be replaced gradually with skim so that by the end of the fourteenth week skim only is being fed. When skim is introduced, if not before, concentrates should be offered. A mixture of one part of simsim cake to six of maize or of mixed maize and bran is suitable. A tablespoonful of cod-liver oil may with advantage be added to each gallon of skim. It is important to remember that all changes should be introduced gradually.

All utensils used for feeding calves should be kept scrupulously clean. After use they should be washed in clean water, sterilized and left inverted in a clean place until required again. Do not rinse a sterilized bucket out with water before use and never leave it in a dusty passage. For sterilization, hot water, steam or a solution of chlorinated lime are preferable. With the two former, allow plenty of time and with the latter see that the same solution is not used day after day. In all cases make sure that the buckets are washed free of milk before sterilizing.

When controlling disease, see that buckets are washed and sterilized between the feeding of each calf. Although theoretically desirable as a routine procedure, in practice it is not always possible to adopt such a plan. It should be remembered, then, that the youngest calves are the most susceptible to disease and, therefore, they should have the benefit of the sterilized bucket. The dairy farmer is inclined to

regard his newly-calved cows producing colostrum and the calves which must have their own mothers' milk as a bit of a nuisance. In the rush to "get the milk off" they are often left till last, with the result that the most susceptible calves get the dirtiest buckets.

Except when it is raining, calves should be allowed to go out in a paddock during the day. It should be stressed that one paddock should not be reserved for calves continuously. At least four small paddocks should be made for calves and they should be used in rotation. The length of time that the calves are sent to one paddock will depend upon the size of the paddock and the number of the calves; but the paddocks should be changed as soon as the grass begins to get short or the land becomes fouled. The establishment of a number of proper calf paddocks simplifies disease control, for should an outbreak occur the healthy calves may be moved without delay to a clean paddock.

Other Systems of Calf-rearing

The other systems of calf-rearing practised are modifications of these already described. They are the foster-mother, the ranch dairying and the outdoor dairying or Hosier system.

The foster-mother system consists in bringing up two calves on the one cow. Provided that suitable cows are selected for foster-mothers, the method is comparable to the ranching method and the remarks given under that heading apply.

By ranch-dairying is meant the system under which calves run with their mothers during the day and are shut up separately at night so that the mothers can be milked in the morning. From the hygienic point of view this system combines the pitfalls of the ranching system with the necessity for further concentration of cows and calves at milking time since cows treated in this manner will usually refuse to "let down" their milk unless the calf is near. In addition, careful experiment has shown that a herd of cows changed over from this system to a hand-rearing system produced 25 per cent more milk. In other words, ranch-dairying is an un-economic as well as an unhygienic system.

The Hosier system is deservedly popular in Kenya. It is the logical outcome of the application of hand-rearing to large herds in areas where the rainfall and grazing will not allow of intensive management. By this method movable milking bails and calf-pens are substituted for permanent buildings and the milk herd may be moved about the farm as a unit.

In so far as calf hygiene is concerned, attention should be devoted to the points on feeding that have been mentioned in connexion with hand-rearing in permanent houses. The sterilization of buckets naturally becomes rather more difficult as supplies of boiling water are much more difficult to maintain. Chlorinated lime will be found useful.

It is also more difficult to arrange for the isolation in individual pens of the very young calves, since, of necessity, the pens must be made as light as possible. A separate unit for these smaller calves is recommended. Calf-pens should, of course, be moved frequently, more especially in wet weather.

The points requiring attention in calf-rearing have been mentioned in the hope that they may be useful in enabling farmers to avoid outbreaks of calf disease and to check their methods when disease occurs. Some of these recommendations may appear to be so obvious that their inclusion seems unwarranted, but in the course of investigations on calf mortality one finds that any or all of them are liable to be disregarded in Kenya.

Calf-rearing in countries like Kenya is never easy and much has still to be learnt. Recent experiments in Scotland have shown, for example, that during the winter months the vitamin A content of the milk falls and that white scour is more common in calves whose dam's milk is deficient in this vitamin. It is probable that dry weather in Kenya may also affect the vitamin A content of milk, and only experiment will show whether in East Africa some of the outbreaks of white scour which are so difficult to control are due to deficiency of this essential factor. For the moment, however, much can be done to improve the hygienic conditions under which our calves are kept.

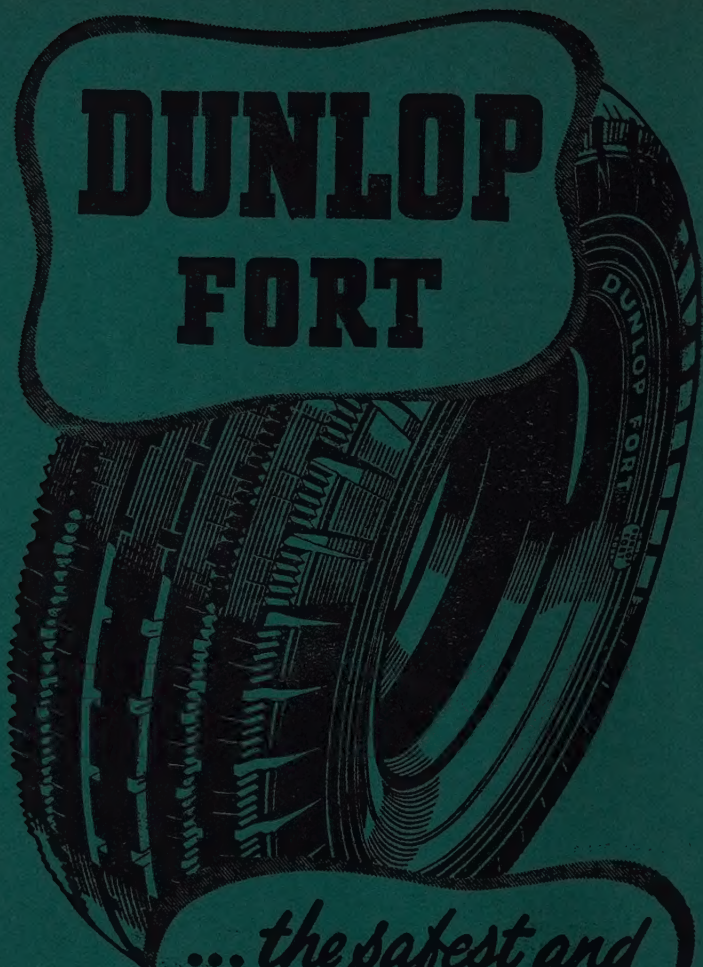
"We have far to go, apparently, before it is at all generally accepted that land is the heritage of each generation, which is responsible for handing it on to future generations with fertility unimpaired."

Agricultural Gazette, N.S.W., July, 1941.

There is no doubt that the love of nature is latent in every human being, and that essentially man is not only interested in his contacts with his fellows and in the products of human ingenuity and human folly.

Sir George Stapledon.

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